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MULTIPLE MODEL FORECASTING AS AN ALTERNATIVE TO THE STANDARD BASE SUPPLY SYSTEM (D002A) FORECASTING TECHNIQUE

Vincent A. Abruzzese, Captain, USAF
George J. Borowsky, Captain, USAF

LSSR-23-81

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER LSSR 23-81	2. GOVT ACCESSION NO. AD-A105 074	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MULTIPLE MODEL FORECASTING AS AN ALTERNATIVE TO THE STANDARD BASE SUPPLY SYSTEM (D002A) FORECASTING TECHNIQUE		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Vincent A. Abruzzese, Captain, USAF George J. Borowsky, Captain, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS School of Systems and Logistics Air Force Institute of Technology, WPAFB OH		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Department of Communication and Humanities AFIT/LSH, WPAFB OH 45433		12. REPORT DATE June 1981 13. NUMBER OF PAGES 90
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Air Force Institute of Technology (ATC)
Wright-Patterson AFB, OH 45433

18. SUPPLEMENTARY NOTES

7 AUG 1981

APPROVED FOR PUBLIC RELEASE AFR 190-17.

Fredric C. Lynch

FREDRIC C. LYNCH, Major, USAF
Director of Public Affairs

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Forecasting; SBSS Forecasting; Multiple Model Forecasting; Retail Forecasting; Forecasting Methods

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: John R. Folkeson, Jr., Major, USAF

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The purpose of this thesis was to test multiple model forecasting as an alternative to the Standard Base Supply System (D002A) forecasting technique. Actual data were used from Dover AFB, Delaware. The methods used in the multiple model technique were single exponential smoothing, double exponential smoothing, adaptive exponential smoothing, four-term moving average and eight-term moving average. Results of each technique were compared in terms of mean absolute deviation, bias, and mean absolute percentage error. The results indicated that the multiple model forecasting technique was not optimal when used with the Standard Base Supply System. Recommendations were made based on the analysis.

LSSR 23-81

MULTIPLE MODEL FORECASTING AS AN ALTERNATIVE TO THE STANDARD BASE SUPPLY SYSTEM (D002A) FORECASTING TECHNIQUE

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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June 1981

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MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

DATE: 17 June 1981

COMMITTEE CHAIRMAN

ACKNOWLEDGMENTS

We would like to thank the Air Force Logistics Management Center for sponsorship of this thesis. In particular, Majors Richard Lombardi and Kenneth Faulhaber for their assistance in providing the data used in this research.

We would like to extend a special thanks to First Lieutenants Beverly Dale and Carl Lizza, AFIT/ACD, for providing their technical assistance in overcoming computer problems encountered during critical phases of this research.

Special recognition and appreciation is due to Major John Folkeson, our thesis advisor, whose guidance, suggestions, and assistance materially aided in the completion of this thesis.

Lastly, Captain George Borowsky offers his love and gratitude to Joan, his wife and friend, for her unceasing patience, understanding and support throughout the school year.

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INTRODUCTION

Standard Base Supply System

The Standard Base Supply System (SBSS) is an automated inventory accounting and control system designed to provide timely support to base level activities. The system uses the UNIVAC 1050-II computer for storage and maintenance of records and for the generation of management reports. The system as a whole consists of both manual components and interfacing computer programs. The system consists of four major functional processes--item accounting, accounting and finance, file maintenance, and management reporting (24:1-2). When using the UNIVAC 1050-II on-line computer system, all records affected by a given transaction are updated at the time of transaction input. The system provides remote devices in work centers on base to insure timely communications between man and machine (24:1-5).

The SBSS was designed to help speed the flow of materials from many sources to the base user organizations. The SBSS inventory is stocked by material from Air Force depots, the General Services Administration (GSA), Defense Supply Agency (DSA) and through local procurement (19:1). The SBSS is driven by user demand actions.

The SBSS automatically provides outputs to other management systems. Those outputs, such as requisitions, go to wholesale suppliers such as Air Force Logistics Command (AFLC) and the Defense Logistics Agency (DLA). The SBSS imposes, Air Force wide, standard organization, programs and procedures. The organization is designed for ease of customer support and efficiency of internal operation (23:1-6). The entire SBSS is an extension of the basic supply requirements to order, receive, store, and issue property.

Inventory

Inventories are used throughout the world in many organizations, both civilian and military. Inventories can be classified in many ways. The following classification is one convenient way:

1. Production inventories: raw materials, parts and components which enter the organization's product or service in the production/transformation processes. These may be either special items manufactured to user specifications or standard items purchased "off the shelf."
2. MRO inventories: maintenance, repair and operating supplies consumed in the production/transformation processes but which do not become part of the product or service.
3. In-process inventories: semifinished products found at various stages in the production operation.
4. Finished-goods inventories: completed products ready for shipment and/or use [14:189].

Regardless of their classification, inventories serve the primary purpose of decoupling successive stages in the production-distribution-consumption chain (13:1).

Inventories allow production decisions and/or supplier demand decisions to be made independent of supplier procurement decisions where demand is independent or near independent.

Inventory Control

Inventory control is a vital element in the management of system resources. Development of analytical techniques and computer capability have combined to transform inventory control into a critical function requiring professional managerial skills (14:187).

The significance of the inventory control function is clearly demonstrated by the level of resources involved. Studies have shown that a commercial firm's inventory commonly constitutes anywhere from 15 to 25 percent of its total invested capital (14:187). In its everyday operations, inventory control is often a computerized operation within a carefully defined and controlled structural framework (14:225). Sound management in the area of inventory control is vital. Management must try to balance the various risks of low inventory with its associated risk of stock out, production halts, back orders; and high inventory with its risk of high carrying cost and increased risk of obsolescence (23:142). To achieve this management objective a forecast of future demand must be made. This forecast is based on uncertain economic cycles, customer demands, and

advances in technology. In light of this uncertain environment, inventory control must answer how much to order and when to order it (13:2).

Generally speaking, three basic systems have been employed in controlling inventories: (1) the cyclical ordering system, (2) fixed order quantity system, and (3) material requirements planning system (14:194). The first system is a time-based system involving scheduled periodic reviews of the stock level of all inventory items. The second type--the fixed order quantity system--is based on the order quantity factor rather than on a time factor. The material requirements planning system concept provides a way of looking at the management of production inventories in a dependent demand environment (14:194). Regardless of the system used, management must have an accurate assessment of what will happen in the future in order to make its decisions (13:2).

Forecasting

In almost any activity, having perfect knowledge of the future would be an immense help. Rather than the certainty of perfect knowledge, the inventory manager finds himself in an uncertain environment. He can do little to change that environment so he seeks management techniques which will aid in reducing the levels of uncertainty. All forecasting techniques have in common the basic goal of

reducing the uncertainty in one's expectation of the future (4:1). As Robert L. Sims says, "It should be obvious that to forecast is to be wrong. Only in the most fortuitous cases, and these seldom occur, can a forecaster guess the future exactly [21:1]." Today, the economics of spiraling prices and austere budgets make reliable estimates, or forecasts, especially critical (3:22). Forecasting for and acquiring spare parts is an important facet of the material support system. Forecasts are used to develop dependable systems and to formulate decisions concerning the technological and economic feasibility of retaining a system in use (11:15). The exponential acceleration of spares cost provides a compelling reason for basing requirements computation upon the best available forecasting methodology (3:22).

Standard Base Supply Forecasting System

The Air Force Logistics Command (AFLC), throughout its Air Logistics Centers (ALCs) or depots, buys and distributes centrally procured items of supply used on missiles, aircraft, and other equipment. Each depot buys and stocks items in specific federal supply classes (FSCs) and serves as the primary source of supply for Air Force bases and other activities (24:11-1).

The SBSS is driven by user demand actions. When a base needs an item a requisition is submitted to SBSS. If the item needed is not currently in stock, a request for

that item is placed on order. The request may be filled through the normal operating cycle. In some instances, special orders may be needed. Orders for resupply of the SBSS are logged as due-ins and are maintained until the material is received (19:1).

Repair parts and supplies with expendability, repairability, recoverability category (ERRC) designator XB3 will be stocked, using a variable economic order quantity (EOQ) stockage concept. An XB3 item is an expendable item, i.e. an item consumed in use or incorporated into another assembly. The EOQ model is applicable when the quantity of items ordered arrives in the inventory at one point in time and when the demand for the item has a constant, or nearly constant, rate; and the cost of the item is relatively low (2:497). The SBSS requirements determination may be divided into the range model and a depth model. The range model refers to the procedure used to determine if an item is to be stocked at the base level. The depth model is used if the item is to be stocked to determine how much to order and when to order it. The depth model is based on the classic EOQ formula:

$$EOQ = \sqrt{2DA/IP} \qquad (1.1)$$

where, D = annual demand rate
A = cost per order (currently used figure, \$4.54)
I = annual inventory carrying rate (currently used figure, 26 percent)
P = item unit price (19:2)

This formula balances the cost of ordering with the cost of holding inventory. The derived order quantity will minimize these total variable costs (19:2).

The Air Force application of the EOQ concept produces a variable requisition objective by determining the EOQ in consideration of the number of demands, daily demand rates, and a stockage priority code. The purpose of the variable EOQ stockage concept is to prevent the premature stockage of items based on erratic or indefinite demand patterns (24:11-2). The basic EOQ model has been enhanced to better meet the variable stockage objectives (VSO) of the SBSS:

$$EOQ_{VSO} = \sqrt{2 \cdot DDR \cdot VSO \cdot A/(I \cdot P)} \qquad (1.2)$$

where,
A = cost per order ($4.54)
I = annual inventory carrying rate (26 percent)
P = item unit price
DDR = daily demand rate
VSO = number of days in the EOQ computation (19:3)

Another important concept incorporated into the SBSS is that base supply levels are managed on a reorder point basis. That is, each time the stock position of an item reaches or falls below the established reorder level, some type of supply action must be taken to bring stocks up to quantities authorized (24:11-2). The reorder point is a combination of the order and shipping time quantity (OSTQ) and the safety level quantity (SLQ). The OSTQ is

that quantity required by a base to permit uninterrupted replacement from the external supply source. The OSTQ is given by:

$$OSTQ = DDR \cdot OST \qquad (1.3)$$

where, DDR = daily demand rate
OST = average order and shiptime in days, based on the item source and priority (19:3)

The safety level quantity is a variable quantity, in units, computed to provide protection from stockouts during the reordering process. The SLQ is given by:

$$SLQ = C \sqrt{3 \cdot OSTQ} \qquad (1.4)$$

where, C = the safety factor (typically set to 1, which implies an 84 percent service effectiveness, given the assumption of normally distributed demands)
3 = lead time demand variance/mean ratio
OSTQ = order and shiptime quantity (19:3)

The reorder point (RP) is given by:

$$RP = OSTQ + SLQ \text{ (19:3)} \qquad (1.5)$$

The maximum desired inventory position is called the requisition objective (RO):

$$RO = INT\ (EOQ_{VSO} + OSTQ + SLQ + 0.999) \qquad (1.6)$$

where, INT = integer result of the following computation
EOQ_{VSO} = enhanced EOQ model
OSTQ = order and shiptime quantity
SLQ = safety level quantity
0.999 = factor added to the EOQ level to adjust to the next highest unit (19:4)

It can be seen that each of the three variables in the requisition objective computation are a function of the daily demand rate. The daily demand rate is the forecast measurement for the SBSS. If inaccurate estimates for DDR are made, errors may result (19:3).

When an item is ordered the daily demand rate is revised. The SBSS maintains status on the cumulative recurring demand (CRD) and the date of first demand (DOFD). Each time an item is ordered, the number of units ordered is added to the CRD. The revised DDR is then:

$$\text{DDR} = \text{CRD}/\max\,(180,\ \text{Current Date} - \text{DOFD}) \qquad (1.7)$$

The minimum of 180 days usage is assumed so as not to overstock items that have been recently added to the stockage list (19:3). The number of demands for each ERRC code XB3 item will be recorded in six-month increments up to a total of three increments or 18 months; i.e., the current and two past six-month increments. When 18 months' demands have been accumulated, the oldest six-month increment will be dropped and a new six months' accumulation will begin. The criteria for establishing demand levels for EOQ items (ERRC code XB3) will vary dependent upon the stockage priority code, but will not be less than three demands per year (24:11-3).

Problem Statement

The literature search has shown that a significant error variance exists in the forecasting method employed in the Standard Base Supply System when compared to the actual demand experienced. The current forecasting system used by the SBSS is a combination of exponential smoothing and moving averages. The literature suggests that this technique may not provide the best estimate of future demand.

A critical measurement used in SBSS is forecasted demand. A forecasting approach which reduces forecast error has potential impact beyond its effect upon economic order quantity (EOQ) determination. Accurate demand data in the context of the SBSS affect average inventory levels and holding costs, and improve order and shipping time (lead-time), thereby impacting safety stock levels and premium transportation requirements for priority back orders.

This thesis explores whether a multiple model forecasting technique can improve demand forecasts.

Research Objectives

The objectives of this thesis are:

1. Evaluate the multiple model forecasting technique as an alternative to the Standard Base Supply System forecasting technique.

2. Determine which forecasting approach will provide the most accurate estimate of future usage.

3. Determine the effectiveness of implementing the proposed system.

4. Recommend actions based upon the results obtained.

Research Justification

This thesis applies the research of Mitchell and Garland at the wholesale level of demand to retail level forecasting. Those authors used simulated and limited actual data to conclude that the multiple model forecasting techniques actually forecasted more accurately than the single method currently used in the Air Force's wholesale level D062 system (13:42). This thesis had the sponsorship of the Air Force Logistics Management Center (AFLMC), Gunter Air Force Station, in a continued effort to improve present inventory control methods.

Scope

This thesis will utilize a research data base maintained by AFLMC and containing two and a half years of data from Dover Air Force Base, Delaware. The data base contains approximately 15,000 line items (National Stock Numbers). The data were tested using several different forecasting techniques. The results were compared to results obtained by previous research on the SBSS.

Chapter 2

LITERATURE REVIEW

Background

Major Richard Lombardi of the Stocking Policies Division, Air Force Logistics Management Center, summarized the current dilemma of logisticians faced with forecasting requirements to meet mission demands:

> The Standard Base Supply System (SBSS) demand forecasting is an unorthodox prediction scheme which may lead to suboptimal forecasting. This is attributed to the manner in which the daily demand rate (DDR) is updated by six month adjustments in the SBSS cumulated recurring demand (CRD) and the date of first demand (DOFD) fields. The net effect of those adjustments is to convert the forecasting to a form of exponential smoothing in which the value of the smoothing constant will vary depending upon date of demands. This variation may, depending upon when demands are experienced, provide more weight to past demands at the expense of current demands, thus dampening the influence of current requirements [15].

Multiple Model Forecasting Method

In order to choose an effective forecasting system, the forecaster must decide upon a model which is most appropriate given the conditions that exist at the time of the forecast. A variety of forecasting models are available from which the forecaster can choose. The selection of a forecasting method depends on many factors: the context of the forecast, i.e., the nature of the decision environment

at the time of the forecast, the relevance and availability of historical data, the desired accuracy of the forecast, and the time period to be covered (13:11). Due to these factors, certain types of forecasting techniques are better suited to a particular demand pattern than others. Since in practice we are seldom faced with a pure "classical" demand pattern, the forecaster should consider several methods for forecasting a single demand pattern before selecting the model best suited to the actual demand pattern.

The multiple model forecasting method used in this thesis research incorporates forecasting techniques recommended by a variety of experts. These techniques are moving average, single exponential smoothing, double exponential smoothing, and adaptive exponential smoothing. The computer was programmed with these simple forecasting strategies. Through the process of simulation, the computer will select the one best strategy to forecast an item at a given moment in time. Whichever strategy best projected the most recent completed period is the one the computer uses to project the future (22:3).

Focus Forecasting

A new approach to inventory control using the concept of declining computer costs per computation is advocated by Bernard T. Smith in his book, Focus Forecasting:

Computer Techniques for Inventory Control (22). Focus forecasting as implemented by Smith used a series of simple forecasting approaches. It uses the powerful computation simulation ability of the computer to pick the one forecasting strategy that will work best for the one item for the next period (22:xii). Focus forecasting goes through all the computations every time it forecasts a demand.

Several parallel research efforts have been accomplished using various forecasting techniques at the wholesale level on the AFLC D062 inventory control system for expendable items and the AFLC D041 reparable asset management system. A summary of these theses follows.

Garland and Mitchell

The purpose of their study was to determine if a multiple model forecasting technique could forecast demand more accurately than the model currently used in the Air Force Logistics Command D062 system for expendable items. Simulated and actual data were used to check the results. The methods utilized in the multiple model technique were an eight-quarter moving average, a four-quarter moving average, exponential smoothing, adaptive smoothing, a least squares fit and a ratio of change between years method. Results were compared in terms of mean absolute deviation adjusted to show percentage change in accuracy compared to the D062. The statistical test used for comparison was the

t-test for matched pairs. This test indicated approximately a 17 percent improvement in accuracy using either simulated or real historical data.

Christensen and Schroeder

This research effort compared the D041 Single Moving Average forecasting method used to forecast reparable generations of recoverable items with the Box and Jenkins' time series analysis forecasting methods. Five artificially generated stochastic processes were used to model the possible reparable generations observed in practice: (1) a Poisson process with a constant mean, (2) a Poisson process with a decreasing mean, (3) a Poisson process with an alternating linear mean, and (4) a process whose values are the sine function of the output of a Poisson process. The research concluded that the D041 forecasting method made unbiased forecasts for the Poisson process with a constant mean and the sine function, but made biased forecasts for the other three processes. Time series analysis forecasting methods were only used to make forecasts for the processes that were found to be biased using the D041 forecasting method. Time series analysis forecasting methods made unbiased forecasts for the processes whose means were linearly increasing, linearly decreasing, and alternating linearly.

Brantley and Loreman

This research effort examined the forecasting technique used in the Air Force Logistics Command D041 reparable asset management system. It was hypothesized that the mean of the absolute values of the D041 forecast error in practice was equal to zero. This hypothesis could not be rejected. It was further hypothesized that another time series forecasting technique (exponential smoothing) would also yield an error distribution with a mean of zero. This hypothesis could not be rejected either; moreover, the variances for the exponential smoothing forecast error distributions were less than the D041 forecast error distributions for all four lead times examined (one, two, three and four quarters).

Fischer and Gibson

This thesis effort examined the application of exponential smoothing to forecast demand for economic order quantity items. The research team stated that management of EOQ items required the use of a demand forecasting technique to estimate future demand for the purpose of establishing stock levels. The study compared the effectiveness of four forecasting models that could be used at base level. The moving averages method and single, double and triple exponential smoothing were evaluated using 22 months of demand history for a random sample of 34 EOQ items stocked at a

base consolidated supply activity. Four statistical error measures were used to compare the accuracy of the forecasts generated by the models for the items. The study concludes that the methods were not significantly different in forecasting EOQ items in terms of accuracy, stability and bias. The study team recommended a reporting system be considered that would permit the study of the application simultaneously of various forecasting techniques to the management of an item and the factors affecting item demand patterns.

Patterson

The purpose of this research was to look into alternate approaches to forecasting demand for expendable items in the SBSS. The forecasting models studied were single, double and adaptive exponential smoothing. Sample items were selected from the actual demand records from Dover AFB. An analysis of the various models was performed by means of a computer program written for each model. The forecasting models were compared on the basis of forecast error as measured by the mean absolute deviation (MAD). The forecast error for the model currently used by the SBSS was also measured. The research study concluded that the single exponential smoothing method, using small smoothing constants, produced the lowest error rate.

Conclusion

The literature search has revealed that the current forecasting system used by the SBSS may not provide the best estimate of future demand. Additionally, the literature search has shown the SBSS forecasting method exhibits a significant error variance when compared to actual demand. These facts lead to several research questions which this research effort will explore.

Research Questions

1. Is there a significant error variance in the multiple model forecasting technique when compared to previous research?

2. Which of the forecasting techniques selected for this study exhibits the smallest error variance, i.e., which technique most accurately forecasts demand?

Hypothesis

The multiple model forecasting technique performs as well as, or better than, single model techniques to which it is compared.

Chapter 3

METHODOLOGY

Introduction

The methodology used in this research effort requires data to be gathered and then analyzed using multiple model forecasting techniques. The results obtained from the multiple model forecasting technique will be compared to the results of techniques used in previous research. Using this procedure recommendations on the performance of the multiple model forecasting technique can be made.

Model Selection

The current Standard Base Supply System (SBSS) is a mixture of moving averages and exponential smoothing. It is a moving average since the Daily Demand Rate (DDR) is a quotient of cumulative demands over time divided by the length of time for which these demands are accumulated (see equation 1.7). It includes exponential smoothing by the way updates to Cumulative Recurring Demand (CRD) and Date of First Demand (DOFD) are performed (19:6). It is not apparent, however, that the current SBSS approach provides the best estimate of future demand. An approach to forecasting which reduces forecast error should provide a more accurate estimate of future demand. The techniques

considered in this thesis are moving average, single exponential smoothing, double exponential smoothing, adaptive exponential smoothing, and multiple model forecasting.

Moving Average

When demand for an item does not have a rapid growth or seasonal characteristics, a moving average can be useful for forecasting. The moving average model would be expected to perform well in normal constant demand situations. This method assumes that the data generating process constitutes a time series:

$$F_t = \bar{D} + e \tag{3.1}$$

where, F_t = forecasted demand for period t
$\bar{D}$ = average demand over time
e = random error variable with a mean of zero as constant variance over time (20:108)

The moving average technique may be described as:

$$F_{t+1} = \frac{D_t + D_{t-1} + D_{t-2} + \dots + D_{t-n+1}}{N} \tag{3.2}$$

$$= \frac{1}{N} \sum_{i=t}^{t-n+1} D_i$$

where, F_{t+1} = forecast for the next period, t+1
$\sum_{i=t}^{t-n+1} D_i$ = actual demand at time t, t-1, t-2 ... t-n+1
N = the number of observations used in the coverage

The effect of moving average forecasting depends on the number of observations used in the coverage (N). If N is large, the equal weighting given to each period is small, and random fluctuations have little effect on the forecast. If N is small, the model is more sensitive to changes in demand (12:17).

Single Exponential Smoothing

In using exponential smoothing, three pieces of data are needed: the most recent forecast, the actual demand that occurred for that forecasted period, and a smoothing constant (α). The equation for a single exponential smoothing forecast is:

$$F_{t+1} = F_t + \alpha(D_t - F_t) \qquad (3.3)$$

where, F_{t+1} = the exponentially smoothed forecast for period t+1
F_t = the exponentially smoothed forecast for the prior period t
D_t = the actual demand in the prior period t
α = the desired response rate, or smoothing constant (13:58)

This equation states that the new forecast is equal to the old forecast plus an adjustment proportional to the difference between the previous forecast and the actual experience. The closer α is to 1, the more the new forecast will incorporate an adjustment for the error in the upcoming forecast. The closer α is to Ø, the less sensitive the new forecast will be to the error in the prior forecast (13:58).

Double Exponential Smoothing

Double exponential smoothing is an extension of single exponential smoothing. It is usually applied to items that exhibit a trend pattern. Both single and double smoothed values lag actual data when a trend exists, the difference between single and double smoothed values can be added to the single smoothed values and thereby adjust for trend (19:11). The single exponential model, equation (3.3), can be rewritten as:

$$S_t = S_{t-1} + \alpha(D_t - S_{t-1}) \qquad (3.4)$$

where, S_i = exponentially smoothed demand in period i. The apparent trend component of the error factor of our forecast is:

$$T_t' = S_t - S_{t-1} \qquad (3.5)$$

This trend component can also be smoothed or averaged over time using:

$$T_t = T_{t-1} + \alpha(T_t' - T_{t-1}) \qquad (3.6)$$

The double exponentially smoothed forecast or the smoothed average forecast including the trend component is the simple smoothed average plus the smoothed trend component as corrected for lag in T_t by the term $(1-\alpha)/\alpha$:

$$F_{t+1} = S_t + \frac{1}{\alpha}T_t \qquad (3.7)$$

In order to use this approach only three data values and a smoothing constant are required. Use of this model should be based on assumptions about the demand pattern. If the time series has a trending average demand rate, the double exponential smoothing model produces an accurate estimate of demand (12:19).

Adaptive Exponential Smoothing

The adaptive smoothing techniques adjust α over time based on the size of the forecasting error. The adaptive model utilized here is the same as in single exponential smoothing with one exception. The value for α is derived from the equation:

$$\alpha_{t+1} = \left| \frac{E_t}{M_t} \right| \tag{3.8}$$

where, $E_t = \beta(e_t) + (1-\beta)E_{t-1}$
$M_t = \beta|e_t| + (1-\beta)M_{t-1}$
$e_t = D_t - F_t$
β = smoothing constant

and $| \ |$ denotes absolute values (16:54).

The characteristic of not specifying a value for α is attractive when thousands of items require forecasting. Also, this method can change the value of α when changes in the pattern of the data have made the initial α value no longer appropriate (16:53).

Multiple Model Forecasting

The model that most accurately forecasts demand will be selected from all models considered. In order to do this, each demand history will be broken into three periods: a base (or start-up) period, a test period, and a prediction period.

The base (or start-up) period is the historical data base required for each model. The length of the base period varies from model to model.

After the forecasting start point is established, each model forecasts demand for a given test period. The forecasts are compared to actual demand for the test period. The model with the smallest variation from the actual demand is selected to forecast demand for the next prediction period.

This is a recurring process in that the forecasting horizon defines a new prediction period; the past prediction period becomes the current test period; the past test period joins the base period data base; and older data are dropped from the base period (13:12).

The multiple model method employed in this research is shown in Appendix D, subroutine "Multi." The actual demand for the four previous forecasting periods is added and stored as a new variable. The values forecasted for these same four periods by each technique are added and this total is subtracted from the total for the actual demand.

This process is repeated for each forecasting technique. The technique which displays the lowest variance from the actual demand is selected by the multiple model technique as the technique it will use to forecast demand for the next period.

Accuracy of Forecasting Models

Demand for an item is generated through the interaction of a number of factors. This interaction is extremely complex. Due to this complexity, all forecasts will contain some error.

In many forecasting situations accuracy is treated as the main criterion for selecting a forecasting method. In spite of this fact, little systematic work has been done to develop a framework for measuring and evaluating accuracy-related issues. One of the difficulties in dealing with the criterion of accuracy in forecasting situations is the absence of a single universally accepted measure of accuracy (16:569). When discussing forecast errors it is appropriate to distinguish between sources of error and the measurement of error.

Sources of error can be classified as either bias or random. Bias errors occur when a consistent "mistake" is made. Random errors can be defined as those that cannot be explained by the forecast model employed.

Several of the common terms used to measure the degree of error are mean absolute percentage error and mean absolute deviation. Additionally, measures of bias may be used to indicate the amount of any positive or negative bias in the forecast (9:241).

Mean Absolute Percentage Error

One approach used to detect forecast error is to take the absolute value of each individual percentage error to obtain the mean absolute percentage error (MAPE).

Percentage error is a relative measure of accuracy and is defined as:

$$PE_t = \left[\frac{D_t - F_t}{D_t}\right](100) \qquad (3.9)$$

where, PE_t = percentage error for any time period t
D_t = actual value for time period t
F_t = forecast value for time period t (16:570)

The equation for computing the MAPE over N time periods is given by:

$$MAPE = \frac{\sum_{i=1}^{n} \left|PE_i\right|}{N} \qquad (3.10)$$

where, MAPE = mean absolute percentage error
PE_i = percentage error for a time period (15:570)

However, the MAPE itself does not always give a good basis of comparison as to the gains in accuracy made by

applying a specific forecasting method. MAPE indicates how well the forecasting model fits the data. In this way, it aids in evaluating how accurate the model is (16:568).

Mean Absolute Deviation

The most straightforward measure of error is mean absolute deviation (MAD). It is computed using the differences between the actual demand and the forecasted demand without regard to sign. Since it is the mean deviation, the sum of the absolute deviations is divided by the number of data points. Stated in equation form:

$$MAD = \frac{\sum_{t=1}^{n} \left| D_t - F_t \right|}{N} \qquad (3.11)$$

where, D_t = actual demand for period t
F_t = forecasted demand for period t
N = total number of periods

and $|\;|$ denotes the absolute value (9:242).

The mean absolute deviation ignores whether the forecast is greater or less than actual demand and simply measures the magnitude of difference.

Bias

Bias indicates the directional tendency of forecast errors. If the forecasting technique used consistently overestimates actual demand, bias will be positive; consistently

underestimating actual demands will cause the bias to be negative. Bias is defined as:

$$\text{Bias} = \frac{\sum_{i=1}^{n} (F_t - D_t)_i}{N} \qquad (3.12)$$

where, F_t = forecasted demand for period t

D_t = actual demand for period t

N = total number of periods (1:331)

Conclusion

All three techniques described here are used to evaluate multiple model forecasting. The measures of error in the forecasting techniques are used to determine which forecasting method will provide the most accurate estimate of demand. By using the forecasting technique which is the most accurate, the error variance in the Standard Base Supply System can hopefully be reduced.

Chapter 4

DATA COLLECTION AND ANALYSIS

Introduction

The purpose of this chapter is to identify the source of data used in the analysis and describe the selection procedure used to obtain a sample of 279 National Stock Numbers (NSNs). Additionally, this chapter will present an analysis of that data.

Data Collection

As mentioned in Chapter 1, this research had the sponsorship of the Air Force Logistics Management Center (AFLMC), Gunter AFS, Alabama. Two computer tapes were provided which contained Standard Base Supply System data from Dover AFB, Delaware, for a two and one-half year period from October 1976 to March 1979. One tape contained item record data for 33 stock classes, ranging from the 1005 to the 5315 stock class. The total number of stock classes was 115 containing a total of 10,607 individual National Stock Numbers. The remaining tape contained transaction history data for these same NSNs. A Fortran program (Appendix A) was developed which aggregated these records by stock class; total items in each class; and total recurring demands.

The next step was selecting the stock classes to be used in the actual analysis. A previous study by Patterson (19) testing alternative forecasting techniques for the Standard Base Supply System (SBSS) used stock classes 28, 47, 59, and 66. It was the researchers' intention to select a sampling of these same classes in order to make a comparative analysis of results. However, since the data only included through the 53 class, two additional alternative stock classes were chosen. A Fortran program (Appendix B) was used to prioritize the data into groups of high activity (frequency of demand) and quantity demanded. With this information, the authors were able to identify the 51 and 53 stock classes as having characteristics that would lend themselves to alternative forecasting methods and, particularly, to the multiple model method. Table 1 shows a capsulized summary of the activity and demands for the four stock classes selected.

Table 1

Profile of Preliminary Data

Stock Class	Total NSN's	Total Recurring Demands
28	386	18,196
47	1313	84,939
51	2407	126,571
53	2331	842,654

Due to the large frequency and quantity of demand data and the limited computer resources, a sampling of this population was taken. Recurring demands were tabulated from the transaction history tape (see Fortran program in Appendix C) and aggregated into 130 weeks or data points for each selected item.

Prior to the selection of the final sample, the data were scanned for any obvious outliers. As in Patterson's research, one stock number (47 stock class) had 6,160 units requested in one period and zero demands for the remaining 129 periods. This item was dropped from the sample. A 28 stock class item was also discarded because data were found to be available only for the first one and one-half years of the survey period.

Table 2 is a summary of the final stock classes used in testing the alternative forecasting methods.

Table 2

Profile of Stock Classes Selected for Analysis

Stock Class	Total NSN's	Total Recurring Demands
28	99	8,137
47	99	14,131
51	31	21,659
53	50	234,689

Summary

In summary, the data used for the actual analysis consisted of centrally procured items identified by the Expendability, Repairability, Recoverability Category (ERRC) of XB3. A total sample of 279 line items was selected based on high activity and a relatively high frequency of reorder periods. An inherent bias in the data collection was the researchers' attempt to identify those stock numbers which exhibited characteristics which would accommodate the time series forecasting techniques to be exercised.

This research addressed the applicability of multiple model forecasting as an alternative to the standard base supply forecasting system. In order to test this hypothesis, the data collected by the methods described were processed by use of a Fortran IV computer program (see Appendix D).

Computer Output

For each stock number in each stock class, the actual units demanded, the units forecasted by each forecasting technique used, and the units forecasted by the multiple model forecasting technique were shown on the output (see Appendix E). The mean absolute deviation (MAD) comparing the forecasted demand and the actual demand was computed (see equation 3.11). Additionally, a bias (equation 3.12) and mean absolute percentage error (MAPE, equation 3.10) were computed. These values were necessary to complete

the statistical tests required to determine the accuracy of the various forecasting methods.

Data Base Comparison

In order to attain the objective of evaluating the multiple model forecasting method, it is necessary to show that a similar data base exists with which to compare our results. In his research, Patterson obtained a mean absolute deviation for single and double exponential smoothing, using an alpha of .2, among others (19:9). A comparison of the means for these two forecasting techniques will test the data base used to see if it is essentially the same as that used by Patterson in his research. The precise stock numbers used by Patterson were unknown to us.

To test this assumption, 95 percent confidence intervals were computed. It is necessary to calculate a value for the standard deviation for Patterson's research, since none was given. When forecast errors are normally distributed, the MAD is related to the standard deviation by:

$$1 \text{ Standard Deviation} = \sqrt{\frac{\pi}{2}} \times \text{MAD} \qquad (4.1)$$

where, $\pi = 3.1416$

or conversely,

$$1 \text{ MAD} = 0.8 \text{ Standard Deviation (9:242)} \qquad (4.2)$$

The central limit theorem tells us that for almost all populations the sampling distribution of the sample mean is approximately normal when the sample size is sufficiently large (18:202). Since the sample size used by Patterson is large (200), normality can be assumed, and a value can be calculated for the standard deviation.

Using this value for the standard deviation of both samples, a 95 percent confidence interval was constructed. To construct a confidence interval, an unbiased estimator of the difference in the two sample means is required. This estimator is denoted by $\bar{D}$:

$$\bar{D} = \bar{Y} - \bar{X} \tag{4.3}$$

where, $\bar{Y}$ = mean of observations from sample 2
$\bar{X}$ = mean of observations from sample 1 (18:312)

Additionally, an unbiased estimator for the standard deviation of $\bar{D}$ is required:

$$s^2(\bar{D}) = s^2(\bar{Y}) + s^2(\bar{X}) \tag{4.4}$$

where, $s^2(\bar{Y}) = \dfrac{s_2^{\,2}}{n}$

$s^2(\bar{X}) = \dfrac{s_1^{\,2}}{n}$ (18:3.6)

The formula for calculating the two-sided confidence interval is:

$$\begin{aligned} L &= \bar{D} - z(1-\alpha/2)s(\bar{D}) \\ U &= \bar{D} + z(1-\alpha/2)s(\bar{D}) \quad (18:316) \end{aligned} \tag{4.5}$$

The results of the confidence interval calculations are shown in Table 3:

Table 3

95% Confidence Interval for Data Base Comparison

Model	Lower Limit	Mean MAD	Upper Limit
	Stock Class 28		
Single Exponential	.6282	2.11	2.5918
Double Exponential	.8670	2.36	2.8931
	Stock Class 47		
Single Exponential	.5062	2.06	2.2938
Double Exponential	.2405	2.47	2.6396

Since the means fell within the limits, we have concluded that for practical purposes our data base and that used by Patterson were essentially the same.

Data Analysis

The results of the computer analysis of the data are shown in Table 4. In three of the four stock classes, on the average, single exponential smoothing consistently displayed the lowest mean absolute deviation. This is contrary to what was expected. The data were selected from the various stock classes based on large amounts of demand occurring in the most time periods. Essentially the "deck

Table 4

Results of Computer Analysis

	Mean MAD	Mean Bias	Mean MAPE
Stock Class 28			
Single Exponential	2.1115	-.6691	88.7535
Double Exponential	2.3659	-.3165	114.7806
Adaptive Exponential	2.9618	.5948	178.4009
4-Term	2.3750	-.2396	117.1407
8-Term	2.2967	-.3491	111.1047
Multiple Model	2.7200	-.2081	152.5846
Stock Class 47			
Single Exponential	2.0682	-1.0852	213.0647
Double Exponential	2.4756	-.1933	278.1608
Adaptive Exponential	3.8648	1.3457	388.1105
4-Term	2.5769	-.2905	265.9312
8-Term	2.3863	-.4338	251.1996
Multiple Model	2.8990	.6206	328.0684
Stock Class 51			
Single Exponential	13.6679	-1.6520	615.5107
Double Exponential	14.8354	.8196	781.0071
Adaptive Exponential	18.1501	3.8259	1081.6932
4-Term	14.4877	-.3390	710.0943
8-Term	13.9992	-.6066	677.3004
Multiple Model	16.1558	1.8196	894.6500
Stock Class 53			
Single Exponential	98.2697	-3.9447	4023.2286
Double Exponential	107.5422	14.2225	5036.5975
Adaptive Exponential	114.3334	15.5944	5373.4977
4-Term	103.0422	-1.0954	4245.1873
8-Term	97.7790	-2.0539	4073.0743
Multiple Model	107.2436	8.0751	4762.1244

was stacked" in favor of the time series techniques. The multiple model technique did not produce the most accurate estimate of demand, nor did it even tie with the most accurate method. In the case of the 51 and 53 stock classes, the MAD for all techniques considered rises considerably. This indicates the problems encountered in using time series analysis on data that are highly erratic and sparse (many zero entires). The MAPE reflects this highly erratic nature. The relatively large values for the MAPEs indicate abrupt changes in the demands in the data (see Appendix E). There are numerous periods in which zero demand is incurred and suddenly a large change in demand occurs and abruptly drops off to zero again.

Conclusion

Through the use of confidence intervals it was shown that the data base used in this research was essentially the same as that used by Patterson in his previous research. The Fortran IV program produced results that indicated single exponential, and not multiple model forecasting, was the most accurate of the techniques considered. The implications and conclusions which have been drawn from this will be further discussed in the next chapter.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This research was directed at exploring the hypothesis: the multiple model forecasting technique performs as well as, or better than, single model techniques to which it is compared. The research addressing this hypothesis led to several conclusions, which can be associated with the four objectives of this thesis.

Conclusions

The first objective of this research was to evaluate the multiple model forecasting technique as an alternative to the Standard Base Supply System forecasting technique. Closely related to this was the second objective, to determine which forecasting approach will provide the most accurate estimate of future demand.

The multiple model forecasting technique and the additional techniques were processed by the use of the Fortran IV program referred to in Chapter 4. Table 4 in Chapter 4 reflects the results of the data analysis. As can be seen, multiple model forecasting did not produce the most accurate estimate of demand. Based on the mean MAD computed after the computer analysis was completed, multiple model

consistently ranked next to last in accuracy. On three out of the four stock classes, single exponential smoothing was ranked as the most accurate. On the fourth class, stock class 53, single exponential smoothing was the second most accurate method, following closely behind 8-term moving average.

The bias is an indicator of the directional tendency of the forecast errors for each forecasting technique. In a perfect forecasting model the bias would be expected to be zero, i.e., the random errors due to overforecasting would be offset by random errors due to underforecasting. Again, referring to Table 4, in three out of the four stock classes analyzed, multiple model forecasting consistently on the average overforecasts the demand. The implications of overforecasting demand come into play when the holding cost of an item is considered. Holding cost is important to any manager concerned with any form of inventory. Holding cost, along with order costs and demand rates, makes up the economic order quantity (EOQ). The multiple model forecasting technique used in this research would cause the holding cost to rise, if only slightly, due to its consistent overestimating of demand and subsequent over-stocking of inventory. Single exponential smoothing, as used in this research, consistently under-estimates demand and therefore again becomes a more acceptable forecasting technique when compared to others, including multiple model.

Finally, the mean absolute percentage error (MAPE) of the multiple model technique consistently ranks as the next to least accurate. The MAPE indicates how well the technique in question fits the data. Therefore, the multiple model forecasting used in this research does not fit the data as well as other methods. Single exponential smoothing fits the data best, i.e., it consistently exhibited the lowest MAPE. The high MAPEs encountered in this research indicate the highly erratic nature of the SBSS. An example of the erratic nature of the demand data is shown in Appendix E. Additionally, it can be seen that, as a general rule, trend is not apparent in SBSS items. Therefore, methods of forecasting that did adjust for trend did not reduce the forecast error. When an abrupt change occurred in the data, both double and adaptive exponential smoothing reacted to the change as if it were a trend. However, the data usually abruptly returned to zero and a trend did not develop. As a result, these forecasting methods were not among the most accurate of the methods tested.

The third objective of this research was to determine the effectiveness of implementing the proposed system. In order to demonstrate a significant cost savings to the Air Force, there must be a significant increase in forecasting accuracy. The results indicate that the multiple model forecasting technique used here would not support this significant increase in forecasting accuracy.

Therefore, any cost savings attributable to implementing the multiple model forecasting technique are in doubt. It also becomes apparent that the time series forecasting models used in this research did not yield any significant improvement in the forecasting of demand for SBSS items.

The final objective of this research was to recommend actions based upon the results obtained. The following section will address this objective.

Recommendations

Implied throughout this study is the fact that inventory models are used to assist managers in determining when items should be ordered and how large the order should be so as to minimize variable costs and insure that adequate stockage is on-hand to meet mission requirements. Using the EOQ model as a depth model, however, has two inherent assumptions, i.e., the demand activity remains relatively continuous and the items are relatively low in cost. Referring to Table 5, we note that this model was intended for use under the conditions which are present in Quadrant I.

Table 5

Inventory Characteristics

		Inventory Item Cost	
		HI	LO
Item Demand	HI	II	I
	LO	III	IV

Quadrant I exhibits the ideal conditions for EOQ, i.e., a high frequency of demand with continuous demand behavior. Scarcity of resources and other fiscal environmental factors have made the conditions within Quadrant II not at all uncommon. Average item costs have been increasing significantly in recent years. The EOQ model, while not optimal, can handle these conditions fairly well as long as the demand patterns remain relatively continuous. In addition to costs, technology factors have increased reliability on many items resulting in lower demand frequency. This has the effect of moving many items into Quadrant III and IV. An example would be vacuum tubes which are now replaced by solid state technology resulting in a higher Mean Time Between Failure. Quadrant III and IV contain characteristics of low demand for both low and high value items. The mathematical assumptions inherent within the EOQ model were not meant to address the conditions of low demand, especially the sparse lumpy conditions found frequently in the SBSS data. Examples of this demand data are found in Appendix E.

We conclude that the EOQ model is an inappropriate depth model for items characterized by erratic and sparse demand patterns. Our recommendation is to divert further efforts from improving SBSS forecasting techniques to directing research efforts in a search for alternative decision models which will be more appropriate for the SBSS depth of stockage decision.

APPENDICES

APPENDIX A

DATA RETRIEVAL PROGRAM

```
      CHARACTER STCLASS*4,CLHOLD*4,STNUMB*15,SNHOLD*15
      INTEGER CLASSCNT,TOTCNT,RDCNT,RD
      READ(20,100,END=900)STCLASS,STNUMB,RD
100   FORMAT(T5,A4,T5,A15,T116,I6)
      TOTCNT=1
      CLASSCNT=1
       CLHOLD=STCLASS
       SNHOLD=STNUMB
       RDCNT=RD
       ITEMCNT=1
       WRITE(6,125)
125   FORMAT("1STOCK CLASS     TOTAL ITEMS     TOTAL RECURRING DEMAND")
       DO 500 K=1,11000
       READ(20,100,END=900)STCLASS,STNUMB,RD
       TOTCNT=TOTCNT+1
       IF(STNUMB.GE.SNHOLD)GO TO 150
       PRINT," ST NUMBERS OUT OF SEQ:REC# ",TOTCNT
       STOP
150    SNHOLD=STNUMB
       IF(STCLASS.EQ.CLHOLD)GO TO 200
       CLASSCNT=CLASSCNT+1
       WRITE(6,1010)CLHOLD,ITEMCNT,RDCNT
       CLHOLD=STCLASS
       RDCNT=0
       ITEMCNT=0
200    RDCNT=RDCNT+RD
       ITEMCNT=ITEMCNT+1
500    CONTINUE
900    WRITE(6,1010)CLHOLD,ITEMCNT,RDCNT
       WRITE(6,950)CLASSCNT
950    FORMAT(///" TOTAL NUMBER OF STOCK CLASSES = ",I6)
       WRITE(6,1000)TOTCNT
1000   FORMAT(" TOTAL NUMBER OF RECORDS = ",I6)
1010   FORMAT(/2X,A4,T18,I9,T33,I11)
       STOP
       END
```

APPENDIX B

SELECTION PROGRAM FOR RANKING BY DEMAND AND FREQUENCY

LIST GE09

```
10 INTEGER SC,TD,IARRAY(131)
20 CHARACTER*15 SN,HOLDSN
30 IFLAG=0
40 HOLDSN="123456789123456"
50 50 READ(40,100,END=500)SC,SN,IDATE,IDEMAND
60 100 FORMAT(T1,I2,T1,A15,T67,I4,T79,I6)
70 IF(SC.GE.53)GO TO 200
90 GO TO 50
100 200 IF(SN.NE.HOLDSN)GO TO 300
110 CALL TALLY(SN,IDATE,IARRAY,IDEMAND,ITOT)
120 GO TO 50
130 300 IF(IFLAG.EQ.0)GO TO 350
140 DO 400 K=1,131
150 IBUCKETS=IBUCKETS+IARRAY(K)
160 400 CONTINUE
170 IBUCKETS=IBUCKETS+100000
180 ITOT=ITOT+1000000000
190 WRITE(50,425)HOLDSN,IBUCKETS,ITOT
200 425 FORMAT(1X,A15,1X,I4,1X,I8)
205 350 IF(SC.GT.53)GO TO 500
210 IFLAG=1
220 HOLDSN=SN
225 IBUCKETS=0
230 ITOT=0
240 DO 450 J=1,131
250 IARRAY(J)=0
260 450 CONTINUE
270 CALL TALLY(SN,IDATE,IARRAY,IDEMAND,ITOT)
280 GO TO 50
320 500 WRITE(6,550)
330 550 FORMAT(" END OF SN PROGRAM")
340 STOP
350 END
360 SUBROUTINE TALLY(SN,IDATE,IARRAY,IDEMAND,ITOT)
370 CHARACTER SN*15
380 INTEGER IARRAY(131)
390 IF(IDATE.GE.6276.AND.IDATE.LE.9091)GO TO 600
400 WRITE(6,575)SN,IDATE
```

```
575 FORMAT(" DATE OUT OF BOUNDS= ",A15,5X,I4)
RETURN
600 CONTINUE
IF(IDATE.GE.6276.AND.IDATE.LE.6366)ISUB=(IDATE-6269)/7
IF(IDATE.GE.7001.AND.IDATE.LE.7365)ISUB=(IDATE-6994)/7+13
IF(IDATE.GE.8001.AND.IDATE.LE.8365)ISUB=(IDATE-7993)/7+65
IF(IDATE.GE.9001.AND.IDATE.LE.9091)ISUB=(IDATE-8992)/7+117
IARRAY(ISUB)=1
ITOT=ITOT+IDEMAND
RETURN
END
```

LIST SORT-1B

```
##NORM,J
$:IDENT:WP1186,AFIT ACDS LT MAIER
$:GMAP:NDECK
:600SM:NOMAP
:SORT:INOUT,,5
:FIELD:(C16,C5,C9)
:SEQ:(D2,D3,A1)
:FILCB:INOUT,**,2
:END
$:EXECUTE
$:LIMITS:10
$:PRMFL:SA,R,S,BOBF/DATA1-47
$:PRMFL:SZ,W,S,BOBF/DATA1-B
$:FILE:S1,X1R,10R
$:FILE:S2,X2R,10R
$:FILE:S3,X3R,10R
$:ENDJOB
```

LIST SORT-1D

```
##NORM,J
$:IDENT:WP1186,AFIT ACDS LT MAIER
$:GMAP:NDECK
:600SM:NOMAP
:SORT:INOUT,,5
:FIELD:(C16,C5,C9)
:SEQ:(D3,D2,A1)
:FILCB:INOUT,**,2
:END
$:EXECUTE
$:LIMITS:10
$:PRMFL:SA,R,S,BOBF/DATA1-47
$:PRMFL:SZ,W,S,BOBF/DATA1-D
$:FILE:S1,X1R,10R
$:FILE:S2,X2R,10R
$:FILE:S3,X3R,10R
$:ENDJOB
```

APPENDIX C

PROGRAM FOR DATA ANALYSIS

LIST MOVEIT

```
10 CHARACTER*15 SN1,SN2
20 INTEGER BUKET1(130),BUKET2(130),BUKET3(130)
30 5 READ(10,10,END=500)SN1,(BUKET1(K),K=1,130)
40 READ(20,10,END=600)SN2,(BUKET2(J),J=1,130)
50 10 FORMAT(A15,5(/26I5))
60 IF(SN1.NE.SN2)GO TO 700
70 DO 30 L=1,130
80 BUKET3(L)=BUKET1(L)+BUKET2(L)
90 30 CONTINUE
100 WRITE(30,50)SN1,(BUKET3(I),I=1,130)
110 50 FORMAT(A15,12I5,7(/15I5)/13I5)
120 GO TO 5
130 500 WRITE(6,550)
140 550 FORMAT(" END OF FILE-1")
150 READ(20,10,END=575)
160 WRITE(6,590)SN2
170 590 FORMAT(" EOF-1,BUT INFO STILL ON FILE-2,SN2=",A15)
180 STOP
190 575 WRITE(6,595)
200 595 FORMAT(" EOF ON BOTH FILES, ALL OK")
210 STOP
220 600 WRITE(6,660)SN1
230 660 FORMAT(" UNEXPECTED EOF-2,SN1=",A15)
240 STOP
244 700 WRITE(6,750)SN1,SN2
246 750 FORMAT(" UNMATCHED SN'S=",A15,2X,A15)
248 STOP
250 END

410 IARRAY(ISUB)=IARRAY(ISUB)+IDEMAND
420 IF(IARRAY(ISUB).GT.99999)WRITE(6,700)SN
430 700 FORMAT( "IDEMAND HAS EXCEEDED 99999, SN=",A15)
440 RETURN
450 END
460 SUBROUTINE INIT(IFOUND,IARRAY)
470 INTEGER IARRAY(130)
480 DO 800 J=1,130
490 IARRAY(J)=0
500 800 CONTINUE
510 IFOUND=0
520 RETURN
530 END
```

```
INTEGER IARRAY(130)
CHARACTER*15 SN,HOLDSN
CALL INIT(IFOUND,IARRAY)
READ(30,10,END=500)HOLDSN
10 FORMAT(A15)
50 READ(40,100,END=499)SN,IDATE,IDEMAND
100 FORMAT(T1,A15,T67,I4,T79,I6)
20 IF(SN.NE.HOLDSN)GO TO 150
IFOUND=1
CALL TALLY(SN,IDATE,IDEMAND,IARRAY)
GO TO 50
150 IF(IFOUND.EQ.1)GO TO 300
IF(SN.GT.HOLDSN)GO TO 200
GO TO 50
200 WRITE(6,250)HOLDSN
250 FORMAT(" THIS SN  NOT ON THIS TAPE=",A15)
GO TO 450
300 WRITE(50,400)HOLDSN,(IARRAY(I),I=1,130)
400 FORMAT(A15,5(/26I5))
CALL INIT(IFOUND,IARRAY)
450 READ(30,10,END=500)HOLDSN
GO TO 20
499 WRITE(6,999)HOLDSN
999 FORMAT(" END OF TAPE=",A15)
500 WRITE(6,550)
550 FORMAT(" END OF SN PROGRAM")
STOP
END
SUBROUTINE TALLY(SN,IDATE,IDEMAND,IARRAY)
CHARACTER SN*15
INTEGER IARRAY(130)
IF(IDATE.GE.6276.AND.IDATE.LE.9089)GO TO 600
WRITE(6,575)SN,IDATE,IDEMAND
575 FORMAT(" DATE OUT OF BOUNDS= ",A15,5X,I4,5X,I5)
RETURN
600 CONTINUE
IF(IDATE.GE.6276.AND.IDATE.LE.6366)ISUB=(IDATE-6269)/7
IF(IDATE.GE.7001.AND.IDATE.LE.7365)ISUB=(IDATE-6994)/7+13
IF(IDATE.GE.8001.AND.IDATE.LE.8365)ISUB=(IDATE-7993)/7+65
IF(IDATE.GE.9001.AND.IDATE.LE.9089)ISUB=(IDATE-8992)/7+117
```

APPENDIX D

PROGRAM TO COMPUTE FORECASTS AND PERFORM COMPARATIVE ANALYSIS

```
C***************************************************************
C     STAR  PROGRAM COMPUTES FORECASTS USING MULTIPLE TECHNIQUES
C     AND PERFORMS BASIC COMPARATIVE ANALYSIS
C***************************************************************
      PROGRAM STAR(INPUT,OUTPUT,TAPE10=INPUT,TAPE6=OUTPUT)
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      READ(10,901) I
901   FORMAT(I4)
      L=I
      DO 899 J=1,25
      READ(10,900)ISEQ(I),NSN(1),NSN(2),
     1(NDAT(I2),I2=1,12),ISEQ(I+1),(NDAT
     1(I2),I2=13,27),ISEQ(I+2),(NDAT(I2),
     1I2=28,42),ISEQ(I+3),(NDAT(I2),
     1I2=43,57),ISEQ(I+4),(NDAT(I2),
     1I2=58,72),ISEQ(I+5),(NDAT(I2),
     1I2=73,87),ISEQ(I+6),(NDAT(I2),
     1I2=88,102),ISEQ(I+7),(NDAT(I2),
     1I2=103,117),ISEQ(I+8),(NDAT(I2),
     1I2=118,130)
900   FORMAT(I4,1X,A10,A5,12I5,7(/I4,15I5),/I4,13I5)
      J5=L+8
      DO 105 J1=L,J5
      IF(ISEQ(J1).NE.J1) GO TO 898
105   CONTINUE
      CALL SINGEX
      CALL DOUBEX
      CALL ADAPEX
      CALL MOV4
      CALL MOV8
      CALL MULTI
      CALL ERROR
      L=L+9
      I=L
899   CONTINUE
      STOP
898   PRINT 975,ISEQ(J1-1)
975   FORMAT(5X,20HCARD OUT OF SEQUENCE,4X,I4)
      STOP
      END
```

```
C*****************************************************************
C     SUBROUTINE SINGEX COMPUTES SINGLE EXPONENTIAL FORECAST
C     VALUES
C*****************************************************************
      SUBROUTINE SINGEX
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      IFSE(1)=NDAT(1)
      DO 200 I=1,129
      FSE=IFSE(I)+(.2*(NDAT(I)-IFSE(I)))
      IFSE(I+1)=IFIX(FSE)
  200 CONTINUE
      RETURN
      END
C
C*****************************************************************
C     SUBROUTINE DOUBEX COMPUTES DOUBLE EXPONENTIAL FORECAST
C     VALUES
C
C*****************************************************************
      SUBROUTINE DOUBEX
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      IFDE(1)=NDAT(1)
      IFDE(2)=NDAT(2)
      STC=0.0
      DO 300 I=2,129
      ATC=IFSE(I)-IFSE(I-1)
      STC=STC+(.2*(ATC-STC))
      IF(STC.LT.0.) STC=0.0
C     5=1/.2
      FDE=IFSE(I)+(5*STC)
      IFDE(I+1)=IFIX(FDE)
  300 CONTINUE
      RETURN
      END
```

```
C*************************************************************
C     SUBROUTINE ADAPEX COMPUTES ADAPTIVE EXPONENTIAL FORECAST
C     VALUES
C
C*************************************************************
      SUBROUTINE ADAPEX
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      IFAE(1)=NDAT(1)
      ERT=0.0
      EMRT=0.0
      DO 400 I=1,129
      IET=NDAT(I)-IFAE(I)
      IF(IET.EQ.0.) GO TO 370
      GO TO 380
370   ALPHA=0.0
      ERT=0.0
      EMRT=0.0
      GO TO 390
380   ERT=(.2*IET)+(.8*ERT)
      IET=IABS(IET)
      EMRT=(.2*IET)+(.8*EMRT)
      ALPHA=ABS(ERT/EMRT)
390   FAE=IFAE(I)+(ALPHA*(NDAT(I)-IFAE(I)))
      IFAE(I+1)=IFIX(FAE)
400   CONTINUE
      RETURN
      END
C
C*************************************************************
C     SUBROUTINE MOV4 COMPUTES 4 TERM MOVING AVERAGE
C     FORECAST VALUES
C
C*************************************************************
      SUBROUTINE MOV4
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      DO 490 I1=1,4
490   IFMA4(I1)=NDAT(I1)
      IFMA4(1)=NDAT(4)
      DO 500 I=4,129
      FMA4=(NDAT(I)+NDAT(I-1)+NDAT(I-2)+NDAT(I-3))/4
      IFMA4(I+1)=IFIX(FMA4)
500   CONTINUE
      RETURN
      END
```

```
C*************************************************************
C     SUBROUTINE MOV8 COMPUTES 8 TERM MOVING AVERAGE
C     FORECAST VALUES
C
C*************************************************************
      SUBROUTINE MOV8
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      DO 590 I1=1,8
590   IFMA8(I1)=NDAT(I1)
      IFMA8(1)=NDAT(8)
      DO 600 I=8,129
      FMA8=(NDAT(I)+NDAT(I-1)+NDAT(I-2)+NDAT(I-3)+
     1NDAT(I-4)+NDAT(I-5)+NDAT(I-6)+NDAT(I-7))/8
      IFMA8(I+1)=IFIX(FMA8)
600   CONTINUE
      RETURN
      END
C*************************************************************
C     SUBROUTINE MULTI COMPUTES MULTIPLE MODEL
C     FORECAST VALUES
C
C*************************************************************
      SUBROUTINE MULTI
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      DO 690 I1=1,9
690   MS(I1)=0
      DO 720 I=9,129
      NVAR0=NDAT(I)+NDAT(I-1)+NDAT(I-2)+NDAT(I-3)
      NVAR1=(NVAR0-(IFSE(I)+IFSE(I-1)+IFSE(I-2)+
     1IFSE(I-3)))
      NVAR1=IABS(NVAR1)
      NVAR2=IABS(NVAR0-(IFDE(I)+IFDE(I-1)+IFDE(I-2)+
     1IFDE(I-3)))
      NVAR3=IABS(NVAR0-(IFAE(I)+IFAE(I-1)+IFAE(I-2)+
     1IFAE(I-3)))
      NVAR4=IABS(NVAR0-(IFMA4(I)+IFMA4(I-1)+IFMA4(I-2)+
     1IFMA4(I-3)))
      NVAR5=IABS(NVAR0-(IFMA8(I)+IFMA8(I-1)+
     1IFMA8(I-2)+IFMA8(I-3)))
```

```
      M=1
      NVAR=NVAR1
      IF(NVAR2.LT.NVAR) GO TO 705
701   IF(NVAR3.LT.NVAR) GO TO 706
702   IF(NVAR4.LT.NVAR) GO TO 707
703   IF(NVAR5.LT.NVAR) GO TO 708
      GO TO 710
705   M=2
      NVAR=NVAR2
      GO TO 701
706   M=3
      NVAR=NVAR3
      GO TO 702
707   M=4
      NVAR=NVAR4
      GO TO 703
708   M=5
710   MS(I)=M
      IF(MS(I).EQ.1) IMM(I+1)=IFSE(I+1)
      IF(MS(I).EQ.2) IMM(I+1)=IFDE(I+1)
      IF(MS(I).EQ.3) IMM(I+1)=IFAE(I+1)
      IF(MS(I).EQ.4) IMM(I+1)=IFMA4(I+1)
      IF(MS(I).EQ.5) IMM(I+1)=IFMA8(I+1)
720   CONTINUE
      RETURN
      END
C***************************************************************
C     SUBROUTINE ERROR MEASURES THE DEGREE OF ERROR AND BIAS IN
C     THE FORECASTS
C***************************************************************
      SUBROUTINE ERROR
      COMMON NSN(2),NDAT(150),IFSE(150),IFDE(150),
     1IFAE(150),IFMA4(150),IFMA8(150),
     1MS(130),IMM(150),ISEQ(3500)
      DIMENSION ICTR(130)
      SEMAD=0.0
      DEMAD=0.0
      AEMAD=0.0
      A4MAD=0.0
      A8MAD=0.0
      SERE=0.0
      DERE=0.0
      AERE=0.0
      A4RE=0.0
      A8RE=0.0
      SEPE=0.0
      DEPE=0.0
      AEPE=0.0
      A4PE=0.0
      A8PE=0.0
      FMAD=0.0
      FRE=0.0
      FPE=0.0
```

```
      DO 800 I=13,130
       ERR = NDAT(I)-IFSE(I)
       SEMAD=ABS(ERR)+SEMAD
       SERE=ERR+SERE
       IF(ERR.EQ.0.) GO TO 752
       IF(NDAT(I).EQ.0.) GO TO 751
       SEPE=(ABS(ERR/NDAT(I))*100.)+SEPE
       GO TO 752
751    SEPE=(ABS(ERR/1)*100.)+SEPE
752    ERR=NDAT(I)-IFDE(I)
       DEMAD=ABS(ERR)+DEMAD
       DERE=ERR+DERE
       IF(ERR.EQ.0.) GO TO 754
       IF(NDAT(I).EQ.0.) GO TO 753
       DEPE=(ABS(ERR/NDAT(I))*100.)+DEPE
       GO TO 754
753    DEPE=(ABS(ERR/1)*100.)+DEPE
754    ERR=NDAT(I)-IFAE(I)
       AEMAD=ABS(ERR)+AEMAD
       AERE=ERR+AERE
       IF(ERR.EQ.0.) GO TO 756
       IF(NDAT(I).EQ.0.) GO TO 755
       AEPE=(ABS(ERR/NDAT(I))*100.)+AEPE
       GO TO 756
755    AEPE=(ABS(ERR/1)*100.)+AEPE
756    ERR=NDAT(I)-IFMA4(I)
       A4MAD=ABS(ERR)+A4MAD
       A4RE=ERR+A4RE
       IF(ERR.EQ.0.) GO TO 758
       IF(NDAT(I).EQ.0.) GO TO 757
       A4PE=(ABS(ERR/NDAT(I))*100.)+A4PE
       GO TO 758
757    A4PE=(ABS(ERR/1)*100.)+A4PE
758    ERR=NDAT(I)-IFMA8(I)
       A8MAD=ABS(ERR)+A8MAD
       A8RE=ERR+A8RE
       IF(ERR.EQ.0.) GO TO 760
       IF(NDAT(I).EQ.0.) GO TO 759
       A8PE=(ABS(ERR/NDAT(I))*100.)+A8PE
       GO TO 760
759    A8PE=(ABS(ERR/1)*100.)+A8PE
760    ERR=NDAT(I)-IMM(I)
       FMAD=ABS(ERR)+FMAD
       FRE=ERR+FRE
       IF(ERR.EQ.0.) GO TO 765
       IF(NDAT(I).EQ.0) GO TO 761
       FPE=(ABS(ERR/NDAT(I))*100.)+FPE
       GO TO 765
761    FPE=(ABS(ERR/1)*100.)+FPE
765    CONTINUE
800    CONTINUE
```

```
      SEMAD=SEMAD/118.
      SERE=(SERE/118.)*(-1.0)
      SEPE=SEPE/118.
      DEMAD=DEMAD/118.
      DERE=(DERE/118.)*(-1.0)
      DEPE=DEPE/118.
      AEMAD=AEMAD/118.
      AERE=(AERE/118.)*(-1.0)
      AEPE=AEPE/118.
      A4MAD=A4MAD/118.
      A4RE=(A4RE/118.)*(-1.0)
      A4PE=A4PE/118.
      A8MAD=A8MAD/118.
      A8RE=(A8RE/118.)*(-1.0)
      A8PE=A8PE/118.
      FMAD=FMAD/118.
      FRE=(FRE/118.)*(-1.0)
      FPE=FPE/118.
      ICTR(1)=1
      DO 860 I=2,130
860   ICTR(I)=ICTR(I-1)+1
      WRITE(6,900) NSN(1),NSN(2)
900   FORMAT(1H1,///5X,5HNSN: ,2A10)
      I3=1
      I4=15
      II=1
      DO 870 I2=1,8
      IF(II.EQ.4) GO TO 865
      GO TO 861
865   WRITE(6,912)
912   FORMAT(1H1)
      II=1
861   WRITE(6,901)(ICTR(I),I=I3,I4)
901   FORMAT(//5X,8H**WEEK**,4X,I3,14I7)
      WRITE(6,902)(NDAT(I),I=I3,I4)
902   FORMAT(/5X,6HACTUAL,4X,I5,14I7)
      WRITE(6,903)(IFSE(I),I=I3,I4)
903   FORMAT(/5X,8H1-SINGLE,2X,I5,14I7)
      WRITE(6,904)(IFDE(I),I=I3,I4)
904   FORMAT(/5X,8H2-DOUBLE,2X,I5,14I7)
      WRITE(6,905)(IFAE(I),I=I3,I4)
905   FORMAT(/5X,7H3-ADAPT,3X,I5,14I7)
      WRITE(6,906)(IFMA4(I),I=I3,I4)
906   FORMAT(/5X,7H4-4TERM,3X,I5,14I7)
      WRITE(6,907)(IFMA8(I),I=I3,I4)
907   FORMAT(/5X,7H5-8TERM,3X,I5,14I7)
      WRITE(6,908)(MS(I),I=I3,I4)
908   FORMAT(/5X,6HMETHOD,4X,I5,14I7)
      WRITE(6,909)(IMM(I),I=I3,I4)
909   FORMAT(/5X,8HMULTIMOD,2X,I5,14I7)
      I3=I3+15
      I4=I4+15
      II=II+1
870   CONTINUE
```

```
      WRITE(6,901)(ICTR(I),I=I3,130)
      WRITE(6,910)
  910 FORMAT(1H+,90X,3HMAD,8X,4HBIAS,6X,4HMAPE)
      WRITE(6,902)(NDAT(I),I=I3,130)
      WRITE(6,903)(IFSE(I),I=I3,130)
      WRITE(6,911) SEMAD,SERE,SEPE
  911 FORMAT(1H+,84X,3F11.4)
      WRITE(6,904)(IFDE(I),I=I3,130)
      WRITE(6,911) DEMAD,DERE,DEPE
      WRITE(6,905)(IFAE(I),I=I3,130)
      WRITE(6,911) AEMAD,AERE,AEPE
      WRITE(6,906)(IFMA4(I),I=I3,130)
      WRITE(6,911) A4MAD,A4RE,A4PE
      WRITE(6,907)(IFMA8(I),I=I3,130)
      WRITE(6,911) A8MAD,A8RE,A8PE
      WRITE(6,908)(MS(I),I=I3,130)
      WRITE(6,909)(IMM(I),I=I3,130)
      WRITE(6,911) FMAD,FRE,FPE
      RETURN
      END
```

APPENDIX E

COMPUTED FORECASTS AND ANALYSIS

NSN: 5365.C0053576

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	0	[illegible]	3	2	3	3	4	2	4	0	0	0	0	1	3
1-SINGLE	0	0	0	[illegible]	0	0	1	1	1	0	0	0	0	0	0
2-DOUBLE	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0
3-ADAPT	0	0	0	3	2	2	7	6	5	2	0	0	0	0	1
4-4TERM	2	0	3	2	1	2	4	4	4	3	1	0	0	0	0
5-8TERM	2	0	3	2	3	8	4	2	2	2	2	2	2	1	0
METHOD	0	0	0	0	0	0	0	0	4	2	1	1	1	4	5
MULTIMOD	********	********	********	********	********	********	********	********	********	3	0	0	0	0	0

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	288	3	1	3	5	0	1	2	3	0	0	0	2	1	1
1-SINGLE	0	57	46	37	30	25	20	16	13	11	8	6	4	3	2
2-DOUBLE	0	[illegible]	114	80	55	37	25	20	16	13	11	8	6	4	3
3-ADAPT	3	283	257	141	63	27	19	4	2	2	0	0	0	2	1
4-4TERM	1	[illegible]	73	73	73	3	2	2	2	1	1	1	0	0	0
5-8TERM	0	35	36	37	37	38	39	36	37	2	1	1	1	1	1
METHOD	3	3	4	4	5	1	1	4	4	4	4	3	3	3	5
MULTIMOD	[illegible]	283	257	73	73	38	29	16	2	1	1	1	0	2	1

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	1	2	2	2	0	3	0	4	0	0	2	0	2	0	0
1-SINGLE	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
2-DOUBLE	2	1	1	1	1	1	0	[illegible]	0	0	0	0	0	0	0
3-ADAPT	1	1	2	2	2	[illegible]	0	[illegible]	4	3	1	1	0	0	0
4-4TERM	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
5-8TERM	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
METHOD	3	[illegible]	1	3	3	3	3	4	3	4	3	1	5	5	3
MULTIMOD	1	1	2	1	2	0	0	[illegible]	1	3	1	1	0	1	1

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	2	[illegible]	[illegible]	2	73	2	2	[illegible]	[illegible]	2100	0	196	1492	426	1492
1-SINGLE	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	11	[illegible]	21	16	432	345	315	550	525
2-DOUBLE	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	23	19	13	36	23	854	595	485	921
3-ADAPT	0	[illegible]	3	2	2	73	55	36	41	26	1923	1765	1136	1233	892
4-4TERM	[illegible]	1	1	1	1	13	13	19	36	18	543	542	574	947	528
5-8TERM	1	[illegible]	1	1	1	10	10	[illegible]	19	19	281	281	305	482	535
METHOD	5	4	3	3	3	[illegible]	4	3	2	3	3	4	3	2	2
MULTIMOD	0	[illegible]	1	2	2	73	55	19	41	36	1923	1765	574	1233	921
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	306	253	1588	[illegible]	196	1432	135	196	1492	1688	0	0	2473	6	1849
1-SINGLE	718	535	558	784	627	540	730	623	537	728	920	736	588	965	772
2-DOUBLE	797	1123	880	677	1105	727	540	[illegible]	668	537	919	1264	827	588	1342
3-ADAPT	1009	764	535	561	465	400	333	535	499	717	1131	1097	844	1118	1013
4-4TERM	901	323	518	934	561	533	544	471	520	844	893	844	795	1040	618
5-8TERM	722	751	782	731	731	731	731	702	540	688	868	657	657	942	755
METHOD	3	5	2	1	3	2	3	3	2	4	2	4	3	5	4
MULTIMOD	797	764	782	677	627	400	540	535	499	537	893	1264	795	1108	755
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	1773	[illegible]	449	[illegible]	3801	0	0	43	150	0	108	0	0	0	0
1-SINGLE	827	1315	812	739	591	1233	995	788	639	541	432	365	292	233	186
2-DOUBLE	889	353	1318	850	739	531	1373	1252	863	539	541	432	365	292	233
3-ADAPT	1015	1197	929	803	474	1591	1475	1176	792	528	280	191	92	43	19
4-4TERM	881	1323	715	817	595	1152	1152	[illegible]	961	48	48	73	62	25	25
5-8TERM	552	1033	872	718	718	1133	994	984	758	555	555	511	511	36	36
METHOD	3	1	1	1	2	3	1	[illegible]	1	1	4	4	4	4	4
MULTIMOD	[illegible]	1197	912	739	591	591	1475	768	758	541	432	73	62	25	25

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	63	593	251	[illegible]	0	213	1754	45	213	250	130	610	246	500	0
1-SINGLE	148	133	224	229	183	145	153	[illegible]	474	421	386	328	382	354	383
2-DOUBLE	186	149	131	316	309	201	146	172	811	733	575	474	340	446	377
3-ADAPT	8	33	61	72	70	56	50	1232	1058	366	746	457	549	393	431
4-4TERM	0	15	165	227	227	212	115	494	607	660	669	253	290	299	361
5-8TERM	36	33	35	128	113	113	140	361	417	436	392	374	449	479	515
METHOD	4	1	2	2	2	5	2	3	3	3	5	1	1	1	1
MULTIMOD	0	15	224	316	309	211	143	172	1058	366	746	374	382	354	383

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	250	592	499	0	450	130	[illegible]	0	2229	433	0	0	2500	356
1-SINGLE	306	244	245	334	367	293	324	279	223	178	588	557	445	356	784
2-DOUBLE	430	395	244	246	423	471	332	362	279	223	178	998	854	570	367
3-ADAPT	217	95	159	161	222	216	255	248	212	152	1331	1192	956	588	829
4-4TERM	336	185	187	235	360	350	413	252	137	137	582	665	665	665	733
5-8TERM	294	233	243	298	348	273	238	248	248	248	496	463	401	401	657
METHOD	4	3	3	2	2	2	5	3	3	2	3	3	2	2	2
MULTIMOD	306	185	159	161	423	471	332	248	212	152	178	1192	956	570	367

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	0	250	0	0	0	[illegible]	523	450	0	0			
1-SINGLE	598	553	496	398	316	252	201	285	324	259	382.0593	-10.5678	13060.6813
2-DOUBLE	1221	361	528	495	396	316	252	201	369	430	423.4576	62.8000	15522.6579
3-ADAPT	923	591	557	356	205	134	52	142	144	134	450.2373	69.7627	15423.3959
4-4TERM	714	714	776	151	62	52	0	155	275	275	393.7288	-3.6949	12368.6078
5-8TERM	599	593	721	442	388	398	339	153	169	169	377.5508	-6.7203	12703.7063
METHOD	4	[illegible]	1	1	4	4	3	1	5********				
MULTIMOD	1221	714	628	398	316	62	[illegible]	142	324	169	439.0678	43.7966	15789.6068

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WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	0	0	460	0	0	460	0	488	0	0	0	0	0	488	0
1-SINGLE	0	0	0	92	73	53	135	110	185	148	118	94	75	60	145
2-DOUBLE	0	0	0	0	184	127	55	241	164	303	205	134	94	75	60
3-ADAPT	0	0	0	460	488	224	255	170	174	149	110	72	43	24	119
4-4TERM	0	0	460	0	115	115	230	115	237	237	122	122	0	0	122
5-8TERM	488	0	460	0	0	450	0	498	176	176	176	118	118	118	122
METHOD	0	0	0	0	0	0	0	0	3	1	1	3	3	2	5
MULTIMOD	**									149	118	94	43	24	60

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	251	0	200	0	0	0	488	0	0	0	488	0	0	488
1-SINGLE	116	92	123	98	118	34	75	60	145	116	92	73	156	124	99
2-DOUBLE	230	155	99	159	102	141	34	75	60	230	155	99	73	239	158
3-ADAPT	112	192	118	111	117	104	75	51	178	170	143	100	166	163	133
4-4TERM	122	122	184	62	112	112	50	50	122	122	122	122	122	122	122
5-8TERM	122	51	92	92	117	117	117	56	117	117	86	86	122	122	122
METHOD	5	2	5	3	3	5	4	2	3	3	2	4	4	4	2
MULTIMOD	122	51	99	92	117	104	117	50	60	170	143	99	122	122	122

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	488	0	0	488	0	488	0	0	488	0	0	0	0	0	0
1-SINGLE	176	233	190	152	219	175	237	189	151	218	174	139	111	88	70
2-DOUBLE	101	255	263	242	155	283	186	308	198	151	285	183	139	111	88
3-ADAPT	198	303	293	238	248	203	232	200	152	172	157	123	85	53	31
4-4TERM	244	244	244	244	244	122	244	244	122	244	122	122	122	0	0
5-8TERM	183	183	183	183	244	183	244	244	183	183	183	183	122	122	61
METHOD	3	3	3	4	5	3	3	1	2	3	3	3	3	4	4
MULTIMOD	101	303	293	236	244	157	232	236	151	151	157	123	85	53	0

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	[illegible]	563	568	[illegible]	0	[illegible]	559	[illegible]	0	570	0	0	0	0	0
1-SINGLE	56	44	148	232	185	149	113	206	158	132	219	175	140	112	89
2-DOUBLE	76	55	44	252	399	271	133	118	298	196	132	306	263	140	112
3-ADAPT	17	[illegible]	211	411	377	333	133	20[illegible]	166	120	169	164	138	102	68
4-4TERM	[illegible]	[illegible]	142	284	284	284	142	142	142	142	284	142	142	142	0
5-8TERM	51	51	71	142	142	142	142	213	213	213	213	142	142	142	142
METHOD	4	2	1	3	3	5	5	5	1	2	3	3	3	3	4
MULTIMOD	[illegible]	[illegible]	44	232	377	33[illegible]	142	213	213	132	132	164	138	102	68
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	2	563	[illegible]	[illegible]	0	553	0	[illegible]	0	0	0	0	0	0	568
1-SINGLE	71	57	159	127	101	[illegible]	177	141	112	89	71	56	44	35	28
2-DOUBLE	89	71	57	261	176	114	98	274	182	116	89	71	56	44	35
3-ADAPT	42	23	165	154	139	157	215	212	175	122	74	41	21	10	5
4-4TERM	0	[illegible]	142	142	142	142	142	142	142	142	0	0	0	0	0
5-8TERM	71	71	142	71	71	71	142	142	142	142	71	71	71	71	0
METHOD	4	5	5	2	2	4	4	4	4	1	1	4	4	4	5
MULTIMOD	0	[illegible]	142	71	176	114	142	142	142	142	71	56	0	0	0
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	2	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
1-SINGLE	136	103	87	69	55	44	35	28	22	17	13	10	8	6	4
2-DOUBLE	28	244	158	112	71	55	44	35	28	22	17	13	10	8	6
3-ADAPT	216	193	171	127	73	4[illegible]	23	1[illegible]	4	1	[illegible]	0	0	0	0
4-4TERM	142	142	142	142	0	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0
5-8TERM	71	71	71	71	71	71	71	71	0	0	0	0	0	0	0
METHOD	3	[illegible]	3	5	5	1	4	[illegible]	4	4	4	4	4	3	3
MULTIMOD	71	193	171	121	71	71	35	[illegible]	0	0	0	0	0	0	0

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	0	[illegible]	0	[illegible]	0	[illegible]	[illegible]	2	572	0	[illegible]	0	0	0	0
1-SINGLE	3	2	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	174	139	111	88	70	56
2-DOUBLE	4	[illegible]	2	1	0	[illegible]	0	[illegible]	0	0	348	243	166	109	78
3-ADAPT	0	[illegible]	[illegible]	[illegible]	0	[illegible]	0	[illegible]	2	872	774	425	185	72	26
4-4TERM	[illegible]	[illegible]	0	[illegible]	0	[illegible]	[illegible]	[illegible]	0	218	218	218	218	0	0
5-8TERM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	109	109	109	109	109	109
METHOD	3	3	3	3	3	3	1	1	3	3	4	4	5	1	1
MULTIMOD	0	0	0	0	0	[illegible]	0	[illegible]	0	872	774	218	218	109	56

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	[illegible]	0	189	2	151	0	0	0	500	500	500	0	500	0
1-SINGLE	44	35	28	22	55	44	55	52	41	32	125	200	260	208	266
2-DOUBLE	56	44	35	28	22	98	59	98	65	41	32	218	349	439	299
3-ADAPT	9	[illegible]	1	0	38	28	28	26	23	19	286	429	478	449	449
4-4TERM	0	0	0	0	47	47	85	85	38	37	125	250	375	375	375
5-8TERM	109	109	0	0	23	23	42	42	42	42	125	167	206	206	250
METHOD	4	4	4	2	1	2	2	5	5	2	3	3	3	3	1
MULTIMOD	44	[illegible]	0	0	22	44	59	98	42	42	32	429	478	449	449

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	500	2	502	2	500	0	0	2	0	0			
1-SINGLE	212	253	215	272	218	274	213	175	140	112	167.5847	-2.3814	7868.9848
2-DOUBLE	397	263	356	239	348	225	335	219	175	140	175.7458	26.8475	9835.9442
3-ADAPT	277	307	202	218	169	253	131	149	101	61	182.8220	26.8390	10099.7912
4-4TERM	250	250	250	251	251	251	251	125	125	0	164.0339	-.1356	7872.2145
5-8TERM	250	312	312	313	250	250	250	188	188	126	165.7627	.7288	7983.1291
METHOD	1	5	1	4	4	4	3	3	3*******				
MULTIMOD	212	253	312	272	251	251	251	149	111	61	181.3559	16.5254	9585.0066

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WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	0	0	0	0	0	0	0	23	0	0	0	0	0	25	0
1-SINGLE	0	0	0	0	0	0	0	0	4	3	2	1	0	0	5
2-DOUBLE	0	0	0	0	0	0	0	0	0	8	5	2	1	0	0
3-ADAPT	0	0	0	0	0	0	0	0	23	20	11	4	1	0	2
4-4TERM	0	0	0	0	0	0	0	0	5	5	5	5	0	0	6
5-8TERM	23	0	0	0	0	0	0	23	2	2	2	2	2	2	6
METHOD	0	0	0	0	0	0	0	0	3	5	5	5	1	3	5
MULTIMOD	********	********	********	********	********	********	********	********	********	20	2	2	2	0	2

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	33	0	0	0	0	130	0	0	0	0	0	0	0	0
1-SINGLE	4	[illegible]	8	6	4	3	2	21	16	12	9	7	5	4	3
2-DOUBLE	10	7	4	14	8	4	3	2	44	26	16	9	7	5	4
3-ADAPT	1	0	15	12	11	6	5	58	56	40	23	11	5	2	0
4-4TERM	6	5	13	7	7	7	0	25	25	25	25	0	0	0	0
5-8TERM	6	[illegible]	6	6	6	6	5	16	16	16	12	12	12	12	12
METHOD	5	[illegible]	4	3	2	1	3	3	3	4	1	1	1	1	4
MULTIMOD	6	[illegible]	13	7	11	4	2	58	56	40	25	7	5	4	3

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	50	[illegible]	0	0	12	0	2	[illegible]	0	6	0	0	0	13	0
1-SINGLE	2	11	8	6	4	5	4	3	2	1	2	1	0	0	2
2-DOUPLE	3	2	20	12	7	4	5	4	3	2	1	3	1	0	0
3-ADAPT	0	5[illegible]	44	24	10	11	4	2	0	0	6	5	2	0	4
4-4TERM	0	12	12	12	12	3	3	3	3	0	2	1	1	1	3
5-8TERM	0	5	6	6	6	7	7	6	8	1	2	2	2	1	2
METHOD	5	[illegible]	2	2	5	1	1	1	4	4	1	1	2	3	3
MULTIMOD	[illegible]	5	44	12	7	7	4	3	2	0	2	1	0	0	4

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	59	[illegible]	1		5	[illegible]	0	[illegible]	[illegible]	99	0	0	0	0	0
1-SINGLE	1	1?	0	7	5	4	3	2	1	0	19	15	12	9	7
2-DOUBLE	4	1	23	15	9	5	4	3	2	1	0	38	26	17	10
3-ADAPT	3	45	45	29	14	3	2	[illegible]	0	0	99	88	48	20	7
4-4TERM	3	18	18	15	15	0	0	0	0	0	24	24	24	24	0
5-8TERM	2	9	9	9	9	9	9	7	7	0	12	12	12	12	12
METHOD	3	[illegible]	4	4	1	1	1	1	4	5	3	4	4	5	1
MULTIMOD	3	45	45	15	15	4	3	2	1	0	12	88	24	24	12
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	0	0	60	0	0	4	0	0	1	0	0	69	0	0	0
1-SINGLE	5	[illegible]	3	14	11	8	7	5	4	3	2	1	14	11	8
2-DOUBLE	7	5	4	3	25	16	9	7	5	4	3	2	1	27	18
3-ADAPT	2	0	0	61	53	23	15	5	1	1	0	0	69	61	33
4-4TERM	0	[illegible]	0	15	15	15	15	1	1	1	0	0	17	17	17
5-8TERM	12	12	12	7	7	7	9	8	8	8	8	8	9	9	8
METHOD	1	[illegible]	5	3	5	2	5	5	1	1	4	5	3	4	4
MULTIMOD	5	[illegible]	[illegible]	7	53	7	9	8	8	3	2	0	9	61	17
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	0	[illegible]	[illegible]	[illegible]	0	0	0	[illegible]	0	0	0	0	0	0	0
1-SINGLE	6	[illegible]	3	8	6	4	3	2	1	0	0	0	0	0	0
2-DOUBLE	10	5	4	3	13	8	4	3	2	1	0	0	0	0	0
3-ADAPT	14	5	1	9	5	3	1	[illegible]	0	0	0	0	0	0	0
4-4TERM	17	[illegible]	[illegible]	7	7	7	7	[illegible]	0	0	0	0	0	0	0
5-8TERM	8	3	8	12	12	3	3	3	3	3	3	0	0	0	0
METHOD	[illegible]	[illegible]	5	7	2	2	3	3	3	3	3	3	1	1	1
MULTIMOD	17	3	3	12	5	3	4		0	0	0	0	0	0	0

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	0	0	0	0	0	0	132	0	0	0	0	0	0	0	0
1-SINGLE	0	0	0	0	0	0	0	26	20	16	12	9	7	5	4
2-DOUBLE	0	0	0	0	0	0	0	[illegible]	52	34	23	14	9	7	5
3-ADAPT	0	0	0	0	0	0	0	132	117	64	27	10	3	1	0
4-4TERM	0	0	0	0	0	0	0	33	33	33	33	0	0	0	0
5-8TERM	0	0	0	0	0	0	0	16	16	16	16	16	16	16	16
METHOD	1	1	1	1	1	1	1	3	4	4	5	1	1	1	4
MULTIMOD	0	0	0	0	0	0	0	26	117	33	33	16	7	5	4

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	0	0	0	0	61	0	0	0	0	0	0	0	0	108
1-SINGLE	3	2	1	0	0	0	12	9	7	5	4	3	2	1	0
2-DOUBLE	4	[illegible]	2	1	0	0	0	24	15	10	5	4	3	2	1
3-ADAPT	0	0	0	0	0	0	50	53	29	12	4	1	0	0	0
4-4TERM	0	0	6	0	0	0	15	15	15	15	0	0	0	0	0
5-8TERM	0	0	0	0	0	0	7	7	7	7	7	7	7	7	0
METHOD	4	4	3	3	3	2	3	4	4	5	1	1	1	4	5
MULTIMOD	0	0	0	0	0	0	0	53	15	15	7	3	2	1	0

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	0	0	0	0	0	0	0	0	0	0			
1-SINGLE	29	15	12	9	7	5	4	3	2	1	12.1186	-1.8644	521.3208
2-DOUBLE	[illegible]	43	28	17	10	7	5	4	3	2	14.1610	.4831	734.2738
3-ADAPT	100	83	48	21	8	[illegible]	1	[illegible]	0	0	23.4407	9.4407	1639.2224
4-4TERM	25	25	25	25	0	0	0	0	0	0	13.8136	-.1356	688.0697
5-8TERM	12	12	12	12	12	12	12	12	0	0	13.3475	-.2797	668.8185
METHOD	3	4	4	5	1	1	1	4	4********				
MULTIMOD	12	83	25	25	12	5	4	3	0	0	19.6102	4.5932	1169.4032

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WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	0	0	0	250	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
1-SINGLE	0	0	0	0	54	[illegible]	32	25	20	16	12	9	7	5	4
2-DOUBLE	0	0	0	0	0	130	73	48	30	20	16	12	9	7	5
3-ADAPT	0	0	0	0	251	222	122	53	20	7	2	0	0	0	0
4-4TERM	250	0	0	251	62	52	52	52	0	0	0	0	0	0	0
5-8TERM	0	0	0	250	0	0	0	0	31	31	31	31	0	0	0
METHOD	0	0	0	0	0	0	0	0	5	5	4	4	4	4	3
MULTIMOD	******	******	******	******	******	******	******	******	******	31	31	0	0	0	0

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	0	0	0	0	0	130	0	0	300	0	0	0	0	0
1-SINGLE	3	2	1	0	0	0	0	31	24	19	75	60	48	38	38
2-DOUBLE	4	[illegible]	2	1	0	0	0	0	60	42	28	138	95	64	41
3-ADAPT	0	0	0	0	0	0	0	150	133	73	118	109	80	49	27
4-4TERM	0	0	0	0	0	0	0	37	37	37	112	75	75	75	0
5-8TERM	0	0	0	0	0	0	0	18	18	18	56	56	56	56	56
METHOD	3	3	3	3	3	3	2	3	4	3	4	2	4	1	1
MULTIMOD	0	0	0	0	0	0	0	0	133	37	118	75	95	75	30

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	0	0	0	50	0	0	0	53	0	0	0	0	18	0	0
1-SINGLE	24	13	15	12	19	15	12	9	17	13	10	8	6	8	6
2-DOUBLE	35	24	19	15	12	26	15	12	9	25	15	10	8	6	10
3-ADAPT	13	5	2	[illegible]	8	5	4	2	8	7	6	5	4	5	4
4-4TERM	[illegible]	0	0	0	12	12	12	12	12	12	12	12	0	4	4
5-8TERM	37	37	37	[illegible]	5	5	5	5	12	12	12	12	6	8	8
METHOD	1	4	4	1	1	5	1	4	4	1	1	3	3	3	3
MULTIMOD	24	13	[illegible]	[illegible]	19	15	5	9	12	12	10	8	4	5	4

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	0	0	0	0	0	0	233	0	0	0	0	0	0	0	2
1-SINGLE	4	[illegible]	2	1	0	[illegible]	0	45	32	25	20	16	12	9	7
2-DOUBLE	6	4	3	2	1	[illegible]	0	[illegible]	60	56	37	24	16	12	9
3-ADAPT	3	2	1	[illegible]	0	[illegible]	0	203	180	99	43	16	5	1	0
4-4TERM	4	4	0	[illegible]	0	0	0	50	50	50	50	0	0	0	0
5-8TERM	8	2	2	2	2	2	0	25	25	25	25	25	25	25	25
METHOD	3	3	3	3	3	4	5	3	4	4	5	1	1	4	4
MULTIMOD	3	2	1	[illegible]	0	0	0	25	180	50	50	25	12	9	0
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	0	0	50	0	0	50	0	0	50	0	0	50	0	0	0
1-SINGLE	6	4	3	12	9	7	15	12	9	17	13	18	18	14	11
2-DOUBLE	7	5	4	3	21	13	8	24	16	9	25	15	10	26	16
3-ADAPT	1	1	0	51	44	24	27	18	10	10	9	7	17	16	14
4-4TERM	0	0	0	13	12	12	25	12	12	25	12	12	25	12	12
5-8TERM	4	2	0	6	6	5	12	12	12	18	18	12	18	18	12
METHOD	4	3	2	3	2	3	2	1	3	1	1	2	3	3	1
MULTIMOD	0	0	0	3	44	13	27	24	9	10	13	10	10	16	14
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	50	0	51	0	51	0	0	0	0	0	0	0	0	0	209
1-SINGLE	8	15	12	19	15	22	17	13	10	8	6	4	3	2	1
2-DOUBLE	11	3	24	14	27	15	31	19	13	10	8	6	4	3	2
3-ADAPT	10	17	16	25	24	30	28	21	13	7	3	1	0	0	0
4-4TERM	12	12	12	25	25	25	25	12	12	0	0	0	0	0	0
5-8TERM	12	13	12	18	18	13	13	19	13	12	12	6	6	0	0
METHOD	1	1	2	3	3	3	1	1	1	1	4	4	4	4	2
MULTIMOD	8	15	12	11	24	30	28	13	10	8	5	0	0	0	0

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	1	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		0	0	0	0	0	0	0
1-SINGLE	42	37	26	21	16	12	9	27	21	16	12	9	7	5	4
2-DOUBLE	1	87	56	38	23	16	12	5	45	29	17	12	9	7	5
3-ADAPT	209	185	172	44	17	6	2	17	13	9	6	4	2	1	0
4-4TERM	52	52	52	52	0	[illegible]	0	25	25	25	25	0	0	0	0
5-8TERM	26	25	26	26	26	25	25	38	12	12	12	12	12	12	12
METHOD	3	[illegible]	4	5	1	1	5	5	5	2	3	3	3	3	4
MULTIMOD	1	185	52	52	26	12	9	38	12	12	17	4	2	1	0

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	[illegible]	0	0	0	[illegible]	151	[illegible]	0	0	0	0	0	0	50
1-SINGLE	3	[illegible]	1	[illegible]	0	[illegible]	0	3[illegible]	24	19	15	12	9	7	5
2-DOUBLE	4	3	2	1	0	[illegible]	0	[illegible]	60	42	28	18	12	9	7
3-ADAPT	0	1	0	0	0	0	0	151	134	73	31	12	4	1	0
4-4TERM	0	1	0	0	0	0	0	37	37	37	37	0	0	0	0
5-8TERM	0	1	0	[illegible]	0	[illegible]	0	18	18	18	18	18	18	18	18
METHOD	4	4	3	3	3	3	2	7	4	4	5	1	1	4	2
MULTIMOD	0	[illegible]	0	0	0	0	0	[illegible]	134	37	37	18	9	7	8

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	[illegible]	151	0	0	0	0	0	10[illegible]	0	0			
1-SINGLE	14	11	39	31	24	13	15	12	29	23	27.2373	-2.1864	1264.4291
2-DOUBLE	5	23	15	70	46	37	13	15	12	46	30.5678	2.8651	1678.4946
3-ADAPT	9	5	56	60	51	35	21	11	13	12	39.2288	10.4661	2499.5936
4-4TERM	12	12	51	51	37	37	0	[illegible]	25	25	29.5220	-.6695	1422.7726
5-8TERM	6	5	25	25	25	25	25	25	31	31	27.3322	-1.0000	1350.5497
METHOD	5	5	3	3	4	5	1	5	5*******				
MULTIMOD	[illegible]	5	25	[illegible]	51	37	25	12	31	31	33.3339	4.1610	1899.7617

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WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	1	[illegible]	2	0	1	[illegible]	0	1	1	0	0	0	0	2	0
1-SINGLE	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0
3-ADAPT	0	[illegible]	0	2	1	1	0	0	1	1	0	0	0	0	2
4-4TERM	0	[illegible]	2	0	0	[illegible]	0	0	0	0	0	0	0	0	0
5-8TERM	1	[illegible]	2	0	1	0	0	1	0	0	0	0	0	0	0
METHOD	0	[illegible]	0	0	0	0	0	0	3	3	3	1	1	1	3
MULTIMOD	**********	**********	**********	**********	**********	**********	**********	**********	**********	1	0	0	0	0	0

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	[illegible]	0	0	0	0	0	0	1	0	0	0	0	1	0
1-SINGLE	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0
3-ADAPT	1	[illegible]	0	0	0	[illegible]	0	0	0	1	0	0	0	0	1
4-4TERM	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
5-8TERM	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0
METHOD	3	[illegible]	1	3	1	1	1	1	1	3	3	3	1	1	3
MULTIMOD	1	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	1	[illegible]	0	1	0	2	0	[illegible]	2	0	0	0	0	1	0
1-SINGLE	0	[illegible]	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0
3-ADAPT	0	[illegible]	0	0	1	0	1	0	0	2	1	0	0	0	1
4-4TERM	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	1	0	0	0	0	0
5-8TERM	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
METHOD	3	[illegible]	3	1	3	3	3	3	3	3	3	3	1	3	3
MULTIMOD	0	[illegible]	0	0	0	0	1	[illegible]	0	2	1	0	0	0	1

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	[illegible]	1	[illegible]	[illegible]	[illegible]		[illegible]		0	58	0	0	68	68	77
1-SINGLE	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0	[illegible]	1	0	13	10	8	24	29
2-DOUBLE	[illegible]	[illegible]	0	[illegible]	0	[illegible]	[illegible]	[illegible]	4	1	0	26	17	11	35
3-ADAPT	[illegible]	[illegible]	1	[illegible]	0	[illegible]	[illegible]	[illegible]	8	4	48	46	23	29	38
4-4TERM	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0	2	2	2	19	17	17	34	34
5-8TERM	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	1	1	1	9	9	9	18	26
METHOD	3	[illegible]	1	3	3	1	1	[illegible]	2	3	3	4	3	3	3
MULTIMOD	0	[illegible]	1	[illegible]	0	[illegible]	0	2	8	1	48	46	17	29	38

WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	68	[illegible]	9	0	0	58	[illegible]	[illegible]	0	68	0	4	396	0	113
1-SINGLE	38	44	75	29	23	18	28	22	17	13	24	19	15	91	72
2-DOUBLE	50	53	70	47	32	23	19	38	24	17	13	35	22	15	167
3-ADAPT	54	[illegible]	58	44	24	11	15	12	9	6	18	17	15	363	388
4-4TERM	53	73	53	38	19	2	19	17	17	17	17	17	17	116	99
5-8TERM	35	[illegible]	43	36	36	35	35	27	18	9	18	17	17	66	58
METHOD	3	[illegible]	5	1	1	1	4	3	4	4	4	4	2	3	3
MULTIMOD	54	[illegible]	53	36	23	18	23	17	9	17	17	17	17	15	368

WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	360	0	0	0	0	0
1-SINGLE	80	54	51	40	32	25	20	16	12	9	79	63	50	40	32
2-DOUBLE	113	121	81	51	40	32	25	21	16	12	9	149	103	69	45
3-ADAPT	252	131	57	22	8	3	1	[illegible]	0	0	360	320	175	76	29
4-4TERM	127	[illegible]	28	28	0	[illegible]	0	[illegible]	0	0	90	90	90	90	0
5-8TERM	72	72	72	63	63	53	14	14	0	0	45	45	45	45	45
METHOD	4	[illegible]	1	1	4	[illegible]	4	[illegible]	4	2	3	2	2	5	5
MULTIMOD	252	[illegible]	72	40	32	[illegible]	0	[illegible]	0	0	9	320	103	69	45

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	36	[illegible]	[illegible]	42[illegible]	0	[illegible]	0	[illegible]	36	0	454	[illegible]	36	0	0
1-SINGLE	25	27	21	16	96	7[illegible]	53	48	38	37	29	114	91	80	64
2-DOUBLE	32	25	29	21	16	17[illegible]	123	79	51	38	37	29	199	136	105
3-ADAPT	1[illegible]	24	11	4	146	13[illegible]	115	93	51	45	24	165	155	142	102
4-4TERM	[illegible]	3	9	9	114	135	135	10[illegible]	0	9	9	122	122	122	122
5-8TERM	45	43	49	[illegible]	57	57	57	57	57	57	57	113	61	65	65
METHOD	1	4	4	5	3	3	3	3	1	1	5	3	3	3	5
MULTIMOD	45	27	9	9	57	135	115	93	57	37	29	113	155	142	102

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	35	0	36	0	336	0	[illegible]	0	360	25	25	50	0	0
1-SINGLE	51	43	39	31	32	25	33	79	63	50	112	94	80	74	59
2-DOUBLE	68	51	41	39	31	33	25	173	118	78	50	174	125	91	77
3-ADAPT	63	35	35	17	24	13	173	152	132	87	114	111	98	87	57
4-4TERM	9	9	9	9	18	19	138	106	99	99	90	96	142	115	25
5-8TERM	65	55	65	65	13	13	58	58	58	58	99	102	103	107	57
METHOD	5	1	4	4	4	3	3	3	2	2	4	2	2	1	1
MULTIMOD	65	55	39	9	18	19	58	152	132	78	50	96	125	91	59

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	25	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	76	0	0			
1-SINGLE	47	42	33	26	20	15	12	9	22	17	44.7203	-1.8559	1923.5782
2-DOUBLE	59	47	42	33	26	2[illegible]	15	12	9	35	50.7797	6.6271	2404.8715
3-ADAPT	33	23	15	7	3	1	0	[illegible]	76	67	61.5424	15.7458	3391.1404
4-4TERM	18	13	6	6	6	[illegible]	0	[illegible]	19	19	47.0508	-.5085	2091.5061
5-8TERM	57	5[illegible]	6[illegible]	15	12	3	3	3	12	9	45.5017	-.8220	1949.4797
METHOD	1	4	4	4	4	4	3	2	3*******				
MULTIMOD	47	42	6	6	6	[illegible]	0	[illegible]	9	67	53.0254	7.7373	2562.3511

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WEEK	1	[illegible]	3	4	5	6	7	[illegible]	9	10	11	12	13	14	15
ACTUAL	0	[illegible]	43	1	0	[illegible]	0	[illegible]	109	0	0	0	0	59	50
1-SINGLE	0	[illegible]	6	8	6	4	3	2	1	22	17	13	10	8	18
2-DOUBLE	0	[illegible]	6	0	16	[illegible]	5	3	2	1	43	28	18	11	8
3-ADAPT	0	[illegible]	0	43	38	21	9	3	1	46	43	35	23	13	16
4-4TERM	1	[illegible]	43	1	11	11	11	[illegible]	0	27	27	27	27	0	14
5-8TERM	0	[illegible]	43	1	0	[illegible]	0	[illegible]	5	19	19	13	13	13	21
METHOD	0	[illegible]	0	0	0	[illegible]	0	[illegible]	3	3	3	3	1	5	3
MULTIMOD	******	******	******	******	******	******	******	******	******	46	43	35	23	8	21

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	[illegible]	59	0	0	0	0	0	0	0	0	0	68	0	0
1-SINGLE	24	13	15	23	18	14	11	8	6	4	3	2	1	14	11
2-DOUBLE	28	33	25	15	31	20	14	11	8	6	4	3	2	1	27
3-ADAPT	20	13	16	23	22	18	13	8	4	2	1	0	0	68	68
4-4TERM	27	27	27	27	14	14	14	[illegible]	0	0	0	0	0	17	17
5-8TERM	27	27	13	21	21	21	21	13	7	7	7	0	0	8	8
METHOD	5	5	2	3	1	1	1	4	4	4	4	4	2	3	4
MULTIMOD	20	27	13	15	22	14	11	8	0	0	0	0	0	1	68

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	68	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0	10	0	0	0
1-SINGLE	8	21	16	12	9	7	5	4	3	2	1	0	2	1	0
2-DOUBLE	18	[illegible]	[illegible]	23	13	9	7	5	4	3	2	1	0	4	1
3-ADAPT	33	37	24	13	6	2	0	[illegible]	0	0	0	0	10	8	4
4-4TERM	17	34	17	17	17	[illegible]	0	0	0	0	0	0	2	2	2
5-8TERM	8	17	17	17	17	17	8	8	8	0	0	0	1	1	1
METHOD	3	[illegible]	1	[illegible]	1	1	3	3	4	3	3	2	3	2	2
MULTIMOD	17	[illegible]	[illegible]	12	17	[illegible]	5		0	0	0	0	0	8	1

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	0	[illegible]	53	53	0	[illegible]	0	[illegible]	0	0	0	0	3	0	0
1-SINGLE	0	[illegible]	0	11	18	14	11	8	6	4	3	2	1	0	0
2-DOUBLE	4	[illegible]	0	[illegible]	20	34	22	15	6	6	4	3	2	1	0
3-ADAPT	1	[illegible]	0	53	53	[illegible]	0	[illegible]	0	0	0	0	0	0	0
4-4TERM	2	[illegible]	0	13	26	26	25	13	0	0	0	0	0	0	0
5-8TERM	1	1	1	7	14	13	13	13	13	13	13	6	0	0	0
METHOD	1	1	3	3	3	3	1	1	3	3	3	3	3	3	3
MULTIMOD	0	[illegible]	6	53	53	[illegible]	0	8	6	6	0	0	0	0	0
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	53	[illegible]	53	0	0	[illegible]	53	53	0	0	0	0	53	100	0
1-SINGLE	0	[illegible]	8	17	13	10	8	17	24	19	15	12	9	17	33
2-DOUBLE	0	[illegible]	24	14	36	24	12	6	26	38	25	16	12	9	25
3-ADAPT	0	33	47	47	26	11	4	4	19	16	15	13	9	16	61
4-4TERM	0	[illegible]	13	26	26	13	13	13	26	26	26	13	0	13	38
5-8TERM	0	5	6	13	13	13	13	19	26	19	19	13	13	19	32
METHOD	2	[illegible]	3	3	1	1	5	2	5	2	3	3	3	5	3
MULTIMOD	0	[illegible]	47	47	26	11	8	19	26	19	25	13	9	16	32
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	0	[illegible]	0	0	0	[illegible]	0	53	0	0	0	0	0	0	53
1-SINGLE	26	23	16	12	9	7	5	4	13	10	8	6	4	3	2
2-DOUBLE	55	35	22	16	12	9	7	5	4	22	14	9	6	4	3
3-ADAPT	54	43	30	17	8	3	1	[illegible]	3	2	1	0	0	0	0
4-4TERM	38	35	25	0	0	[illegible]	0	[illegible]	13	13	13	13	0	0	0
5-8TERM	25	13	19	19	19	13	12	[illegible]	6	6	6	6	6	6	6
METHOD	3	[illegible]	1	1	1	4	4	5	5	2	2	3	3	3	5
MULTIMOD	54	43	16	12	9	7	0	[illegible]	6	6	14	9	0	0	0

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	[illegible]	1	[illegible]	[illegible]	85	[illegible]	[illegible]	[illegible]	[illegible]	0	0	53	0	0	0
1-SINGLE	12	3	7	5	24	35	29	22	17	13	10	8	17	13	10
2-DOUBLE	2	22	14	9	5	43	53	41	27	17	13	10	8	26	16
3-ADAPT	53	4[illegible]	26	11	26	5[illegible]	45	38	26	15	8	4	5	4	3
4-4TERM	13	1[illegible]	13	13	25	45	45	46	21	0	0	0	13	13	13
5-8TERM	13	5	6	6	19	29	29	29	23	23	23	23	17	6	6
METHOD	3	2	2	3	3	3	3	5	1	1	1	3	1	2	5
MULTIMOD	13	4[illegible]	14	9	26	3[illegible]	45	38	23	13	10	8	5	13	16

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	201	0	0	0	0	0	[illegible]	0	0	55	0	0	0	0
1-SINGLE	8	5	44	35	28	22	17	13	10	8	6	15	12	9	7
2-DOUBLE	14	3	6	82	56	38	24	17	13	10	8	6	24	16	9
3-ADAPT	2	1	145	142	96	50	23	9	3	1	0	8	6	4	2
4-4TERM	13	3	50	50	50	50	0	0	0	0	0	13	13	13	13
5-8TERM	6	5	31	31	31	25	25	25	25	25	0	6	6	6	6
METHOD	3	2	3	4	2	5	1	1	4	4	2	5	2	2	3
MULTIMOD	6	1	6	142	50	38	25	13	10	0	0	6	6	16	9

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	0	1	0	0	0	[illegible]	3	[illegible]	0	0			
1-SINGLE	5	4	3	2	1	[illegible]	0	0	0	0	13.1017	-1.4368	900.1958
2-DOUBLE	7	5	4	3	2	1	0	0	0	0	22.8644	2.3559	1276.3480
3-ADAPT	1	1	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	0	23.7797	4.6182	1433.7621
4-4TERM	0	1	[illegible]	[illegible]	0	[illegible]	0	[illegible]	[illegible]	0	20.7797	.0588	1057.1840
5-8TERM	6	5	6	6	0	[illegible]	0	[illegible]	0	0	20.3983	.2119	1045.6422
METHOD	3	3	3	4	3	3	3	3	1*******				
MULTIMOD	1	[illegible]	[illegible]	[illegible]	0	[illegible]	3	[illegible]	0	0	21.2542	2.1186	1182.7934

NSN: 28[illegible]111'72995

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	[illegible]	[illegible]	0	[illegible]	1	[illegible]	0	[illegible]	0	0	0	0	0	0	0
1-SINGLE	0	[illegible]	[illegible]	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0
3-ADAPT	0	[illegible]	0	0	0	1	4	3	1	0	0	0	0	0	0
4-4TERM	0	[illegible]	0	0	0	[illegible]	1	1	1	1	0	0	0	0	0
5-8TERM	0	[illegible]	0	0	1	4	0	[illegible]	0	0	0	0	0	0	0
METHOD	0	[illegible]	0	0	0	[illegible]	0	[illegible]	5	1	1	1	1	1	1
MULTIMOD	******	******	******	******	******	******	******	******	******	0	0	0	0	0	0

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	3	2	0	0	0	0	2	0	0	0	2	0	1	1
1-SINGLE	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	1	0	[illegible]	0	0	0	0	0	0	0	0	0
3-ADAPT	0	[illegible]	3	2	1	[illegible]	0	[illegible]	2	1	0	0	2	1	1
4-4TERM	0	[illegible]	0	1	1	1	0	[illegible]	0	0	0	0	0	0	0
5-8TERM	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
METHOD	1	1	3	3	3	4	1	4	3	3	3	3	3	3	3
MULTIMOD	0	[illegible]	0	2	1	[illegible]	0	0	0	1	0	0	2	1	1

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	2	[illegible]	0	1	0	[illegible]	0	3	1	2	0	4	1	3	2
1-SINGLE	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
3-ADAPT	1	2	1	[illegible]	0	[illegible]	0	[illegible]	3	2	2	0	1	1	3
4-4TERM	1	1	1	[illegible]	0	[illegible]	0	0	0	1	1	1	1	1	2
5-8TERM	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0	0	1	1	1
METHOD	[illegible]	[illegible]	4	4	1	[illegible]	1	1	3	3	3	3	3	3	3
MULTIMOD	1	2	1	0	[illegible]	[illegible]	0	[illegible]	0	2	2	0	1	1	3

WEEK	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL		[illegible]	[illegible]	1	1	[illegible]	2	125	30	8	50	125	30	143	30
1-SINGLE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	25	26	22	29	48	44	63
2-DOUBLE	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	59	47	34	46	60	66
3-ADAPT	2	[illegible]	1	[illegible]	[illegible]	[illegible]	2	2	125	123	75	68	74	61	69
4-4TERM	2	[illegible]	2	1	1	1	1	2	33	40	41	55	55	55	69
5-8TERM	2	1	1	1	1	1	1	1	17	20	21	28	44	48	65
METHOD	4	[illegible]	5	3	4	4	4	4	3	3	3	4	4	3	3
MULTIMOD	2	1	1	1	0	1	1	2	33	123	75	68	55	55	69
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	0	45	30	[illegible]	0	0	125	0	45	72	66	60	153	0	148
1-SINGLE	56	44	44	41	32	25	27	41	32	34	41	44	47	68	54
2-DOUBLE	99	73	49	48	41	32	25	[illegible]	62	39	42	54	57	61	108
3-ADAPT	66	45	46	30	0	[illegible]	0	125	111	87	81	71	65	74	57
4-4TERM	82	51	54	28	19	19	7	31	31	42	60	44	59	86	68
5-8TERM	68	57	55	58	50	34	31	28	25	36	34	37	45	64	64
METHOD	1	1	1	1	3	3	1	3	2	3	4	2	3	3	2
MULTIMOD	66	44	44	41	32	[illegible]	0	41	111	39	81	44	57	74	57
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	0	157	0	0	0	0	0	[illegible]	0	183	120	0	0	0	69
1-SINGLE	72	57	76	60	46	38	30	24	19	15	48	62	49	39	31
2-DOUBLE	65	93	53	100	63	48	39	[illegible]	24	19	15	81	102	68	44
3-ADAPT	71	57	80	73	52	31	15	6	3	1	64	90	83	68	45
4-4TERM	90	75	75	75	38	33	0	0	0	0	45	75	75	75	30
5-8TERM	67	57	80	71	64	56	37	37	19	19	22	37	37	37	37
METHOD	4	[illegible]	4	1	1	1	4	4	4	5	1	3	3	5	5
MULTIMOD	65	75	75	75	48	73	39	[illegible]	[illegible]	0	22	62	83	68	37

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	121	[illegible]	126	0	0	[illegible]	3	0	0	21	0	180	0	0	0
1-SINGLE	38	54	63	58	46	36	34	27	21	16	17	13	46	36	28
2-DOUBLE	31	45	75	49	78	51	35	34	27	21	16	18	13	79	52
3-ADAPT	50	57	45	54	90	38	35	22	12	6	10	6	87	81	64
4-4TERM	17	47	47	77	60	31	37	7	7	7	5	5	50	50	45
5-8TERM	46	51	61	53	38	33	42	42	33	18	21	6	28	28	25
METHOD	4	2	5	5	1	1	5	4	4	4	4	2	3	3	2
MULTIMOD	46	47	75	53	38	36	34	42	7	7	5	5	13	81	64

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	187	153	0	0	0	0	[illegible]	60	30	160	279	142	255	133
1-SINGLE	22	17	49	71	56	44	33	28	22	29	29	55	99	107	136
2-DOUBLE	33	22	17	81	118	79	50	35	28	22	36	34	85	167	169
3-ADAPT	41	22	41	85	76	58	51	37	19	28	28	63	191	170	215
4-4TERM	45	[illegible]	45	85	65	85	40	0	0	15	22	62	132	152	209
5-8TERM	25	25	47	65	65	42	42	42	42	50	31	31	66	63	115
METHOD	5	2	3	3	2	5	1	1	4	1	5	5	3	3	3
MULTIMOD	33	25	17	85	76	79	42	28	22	15	29	31	66	170	215

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	3	3	0	0	12	0	33	15	0	0			
1-SINGLE	135	103	98	70	56	47	37	35	31	24	37.4746	-2.6102	1495.5173
2-DOUBLE	215	197	170	88	70	55	47	37	35	31	42.5271	5.8983	1941.9689
3-ADAPT	195	155	95	46	20	15	6	16	15	7	41.2966	6.3983	1712.6435
4-4TERM	2[illegible]2	137	176	36	3	5	3	16	14	11	33.6017	-.4492	1547.0346
5-8TERM	132	172	126	122	102	59	51	23	8	8	40.2119	-.8220	1639.6557
METHOD	1	5	1	1	4	4	4	7	3*******				
MULTIMOD	195	133	126	70	56	5	3	16	15	7	40.4153	1.6864	1602.0322

AD-A105 074 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
MULTIPLE MODEL FORECASTING AS AN ALTERNATIVE TO THE STANDARD BA--ETC(U)
JUN 81 V A ABRUZZESE, G J BOROWSKY
UNCLASSIFIED AFIT-LSSR-23-81 NL

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NSN [illegible]

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACTUAL	1	[illegible]	2	1	0	[illegible]	0	1	1	0	0	0	0	0	0
1-SINGLE	[illegible]	[illegible]	[illegible]	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0
3-ADAPT		[illegible]	0	2	1	[illegible]	0		1	1	0	0	0	0	0
4-4TERM	1	[illegible]	2	1	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
5-8TERM	1	[illegible]	2	1	0	[illegible]	0	1	0	0	0	0	0	0	0
METHOD	0	0	0	0	0	[illegible]	0	[illegible]	3	3	3	1	1	1	1
MULTIMOD	******	******	******	******	******	******	******	******	******	1	0	0	0	0	0

WEEK	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ACTUAL	0	[illegible]	0	0	1	[illegible]	0	[illegible]	0	2	1	0	0	1	0
1-SINGLE	0	[illegible]	0	0	0	0	0		0	0	0	0	0	0	0
2-DOUBLE	0	[illegible]	0	0	0	[illegible]	0		0	0	0	0	0	0	0
3-ADAPT	0	[illegible]	0	0	0	1	0	[illegible]	0	0	2	1	0	0	1
4-4TERM	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
5-8TERM	0	[illegible]	0	1	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
METHOD	1	1	1	1	1	[illegible]	3	3	1	1	3	3	3	3	1
MULTIMOD	0	[illegible]	0	0	0	0	0	[illegible]	0	0	0	1	0	0	1

WEEK	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ACTUAL	1	1	0	0	0	[illegible]	0		0	0	0	0	2	0	0
1-SINGLE	0	1	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0
2-DOUBLE	[illegible]	1	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
3-ADAPT	[illegible]	[illegible]	0	0	0	[illegible]	0	[illegible]	0	0	0	0	0	2	1
4-4TERM	[illegible]	1	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
5-8TERM	[illegible]		0	[illegible]	0	[illegible]	0	[illegible]	0	0	0	0	0	0	0
METHOD	3	[illegible]	3	1	1	1	1	1	1	1	1	1	1	3	3
MULTIMOD		[illegible]	0	[illegible]	0	[illegible]	[illegible]		0	0	0	0	0	0	1

WEEK	[illegible]	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ACTUAL	[illegible]	[illegible]	1	1	0		[illegible]	74	0	0	76	49	40	24	0
1-SINGLE	1	1	0	1	0	[illegible]	0	0	14	11	8	13	23	24	24
2-DOUBLE	0	[illegible]	0	0	0	[illegible]	0	0	0	28	19	11	20	33	38
3-ADAPT	0	1	1	1	1	0	0	0	74	65	35	35	38	38	32
4-4TERM	0	[illegible]	0	0	0	[illegible]	0	[illegible]	18	18	18	27	21	31	37
5-8TERM	0	0	0	0	0	[illegible]	0		9	9	9	13	19	24	27
METHOD	3	1	3	3	3	3	1	3	3	4	4	4	4	3	4
MULTIMOD	[illegible]	0	0	1	1	[illegible]	0	0	74	65	18	27	21	31	32
WEEK	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ACTUAL	0	83	0	46	20	24	10	0	0	0	0	0	12	0	40
1-SINGLE	19	15	29	23	26	24	24	21	16	12	9	7	5	6	4
2-DOUBLE	35	27	15	43	28	33	27	26	21	16	12	9	7	5	7
3-ADAPT	14	5	22	21	24	23	23	22	15	9	4	2	0	2	1
4-4TERM	28	15	28	22	32	37	21	23	13	8	2	0	0	3	3
5-8TERM	27	13	29	29	30	26	24	22	22	22	11	11	6	5	2
METHOD	1	4	1	2	2	3	1	3	3	4	4	4	4	3	2
MULTIMOD	28	15	28	23	28	33	23	21	16	9	2	0	0	3	1
WEEK	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ACTUAL	0	[illegible]	46	0	73	0	0		0	0	0	0	0	0	48
1-SINGLE	11	3	6	12	9	21	15	12	9	7	5	4	3	2	1
2-DOUBLE	4	19	10	6	18	17	34	21	12	9	7	5	4	3	2
3-ADAPT	16	14	12	18	17	41	33	29	17	9	4	1	0	0	0
4-4TERM	13	13	10	[illegible]	16	23	29	16	18	5	0	0	0	0	0
5-8TERM	5	5	[illegible]	11	11	[illegible]	13	19	14	14	14	9	9	0	0
METHOD	1	2	3	2	3	[illegible]	2	[illegible]	1	1	1	4	4	4	5
MULTIMOD	4	[illegible]	10	18	18	41	33	21	14	7	5	4	0	0	0

WEEK	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ACTUAL	0	1	1	0	0	1	0	[illegible]	15	46	0	0	0	0	0
1-SINGLE	10	9	6	4	3	2	1	[illegible]	0	3	11	8	6	4	3
2-DOUBLE	1	13	13	6	4	3	2	1	0	0	6	21	13	8	4
3-ADAPT	48	42	23	10	3	1	0		0	15	46	39	29	8	3
4-4TERM	12	12	12	12	0	1	0	[illegible]	0	3	15	15	15	11	8
5-8TERM	6	5	6	6	6	6	5	6	0	1	7	7	7	7	7
METHOD	3	2	4	5	1	1	1	4	5	3	3	4	4	5	1
MULTIMOD	6	42	13	12	6	2	1		0	1	46	39	15	11	7

WEEK	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
ACTUAL	0	1	40	0	0	0	0	[illegible]	0	0	0	0	0	0	0
1-SINGLE	2	1	0	8	6	4	3	2	1	0	0	0	0	0	0
2-DOUBLE	3	2	1	0	16	10	5	3	2	1	0	0	0	0	0
3-ADAPT	1	[illegible]	0	40	35	13	8	3	1	0	0	0	0	0	0
4-4TERM	0	1	0	10	10	10	10	[illegible]	0	0	0	0	0	0	0
5-8TERM	7	7	5	5	5	5	5	[illegible]	5	5	5	0	0	0	0
METHOD	1	1	5	3	5	4	5	1	1	1	4	4	1	1	1
MULTIMOD	2	1	0	5	35	5	10	5	1	0	0	0	0	0	0

WEEK	121	122	123	124	125	126	127	128	129	130	MAD	BIAS	MAPE
ACTUAL	0	[illegible]	[illegible]	0	0	0	40	28	0	0			
1-SINGLE	[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	12	9	9.6186	-1.6356	351.5315
2-DOUBLE	[illegible]	1	0	0	[illegible]	[illegible]	0	[illegible]	16	22	9.5678	.9424	461.4955
3-ADAPT	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	34	25	12.0508	3.3729	751.2304
4-4TERM	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1[illegible]	17	17	9.4661	-.3644	438.4264
5-8TERM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	8	9.4666	-.6949	432.9574
METHOD	1	1	1	1	1	1	1	[illegible]	3*******				
MULTIMOD	[illegible]		0		[illegible]	[illegible]	[illegible]	[illegible]	34	25	11.6949	1.9153	667.9814

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